

variation measured. Then the current is kept constant, and the variation of resistance of potentiometer observed. In the instrument the variation of resistance of the wire is measured by means of the deflection of a galvanometer arranged in a Wheatstone bridge the wire forming one of the arms of the bridge. From the previous observations the scale of the galvanometer can be calculated, and the instrument reads directly.

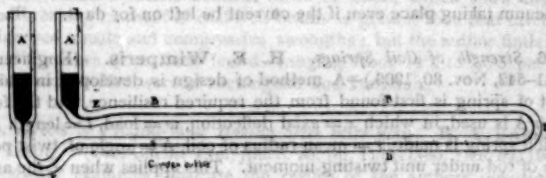
# SCIENCE ABSTRACTS.

## Section A—PHYSICS.

FEBRUARY 1907.

## GENERAL PHYSICS.

173. *Compensated Micromanometer.* B. J. P. Roberts. (Roy. Soc., Proc. Ser. A. 78. pp. 410-412, Dec. 20, 1906.)—A compensating modification of Siemens' bathymeter is described, intended for use as an anemometer and for the indication and measurement of small pressures. The two limbs, A, A', of a U-tube are connected by a tube B of finer bore, which contains an index bulb C, preferably of air, the bends at E forming a trap to prevent accidental



loss of the bubble. The sensitiveness of the gauge depends on the ratio between the bores of the limbs and the connecting tube, and on the fluid employed. The bore of the tube B is preferably about  $1\frac{1}{2}$  mm., and the length of the index bubble C should be approximately equal to the distance between the centres of the limbs A A', the gauge being then practically indifferent to changes of position or level. Pure water cannot be used as the working fluid, its high surface tension rendering the zero-point indefinite, but the addition of glycerine or calcium chloride overcomes this difficulty.

W. H. St.

174. *Vacuum Measurement.* M. v. Pirani. (Deutsch. Phys. Gesell., Verh. 8. 24. pp. 686-694, Dec. 30, 1906.)—This paper gives a description of a direct-reading instrument for measuring the degree of vacuum reached in exhausting (say) an incandescent lamp. Schleiermacher's method of observing the resistance of an electrically heated wire is employed in the instrument. Keeping the potential at the ends of the wire constant, the variation of resistance with the pressure is observed. Next the resistance, and therefore the temperature, of the wire is kept constant, and the energy-

variation measured. Then the current is kept constant, and the variation of resistance or potential observed. In the instrument the variation of resistance of the wire is registered by means of the deflections of a galvanometer arranged in a Wheatstone bridge, the wire forming one of the arms of the bridge. From the previous observations the scale of the galvanometer can be calibrated so that the instrument reads direct. A. W.

175. *Improved Method of exhausting Vacuum and Rectifier Tubes.* (Brit. Pat. 25,047A of 1905. Engineer, 103. p. 26, Jan. 4, 1907. Abstract.)—In the method proposed by O. J. Lodge, A. Muirhead, and E. E. Robinson, use is made of a pump, which may be an ordinary mechanical one, for partially exhausting the tube or vessel, the exhaustion being completed by a combustible or vacuum-increasing substance placed in the tube before the starting of the pump. The substances employed are paraffin wax and yellow phosphorus; three or four pellets of the former, the size of a pea, and two of phosphorus not quite so large, are put in the tube, which is then sealed to the pump. The sequence of operations to be carried out during the working of the pump is described. A moderately good conducting vacuum is reached in a short time, which is determined by attaching the tube to a coil. The tube is then sealed off and detached from the pump. On the current being now put on, fine but evanescent striæ are seen for a time, but the vacuum rapidly runs up, owing to the phosphorus combining with the enclosed gases, and in about a minute becomes high. The tube is then heated slightly to make the paraffin give off vapour and bring the vacuum down to that desired, which is reached in a few minutes. The device then rectifies perfectly and seems to be in a permanent condition, no alteration in the vacuum taking place even if the current be left on for days. L. H. W.

176. *Strength of Coil Springs.* H. E. Wimperis. (Engineer, 102. pp. 541-542, Nov. 30, 1906.)—A method of design is developed in which the weight of spring is first found from the required resilience, and the formula  $x = wl^2/A$  is used, in which  $x$  = axial deflection,  $w$  = load,  $l$  = length of rod of which spring is made,  $r$  = mean radius of coil,  $A$  = angle of twist per unit length of rod under unit twisting moment. This applies when  $\alpha$ , the angle of slope of the helix is small; in other cases—

$$x = l[wr^2(A \cos^3 \alpha + B \sin^3 \alpha) + Lr(B - A) \sin \alpha \cos \alpha],$$

where  $B$  = angle of bend per unit length of rod under unit bending moment, and  $L$  = couple (if any) tending to wind the spring. Incidentally it is pointed out that springs made of circular section rod are not only stronger per pound of spring, but, using the same working stress, a square-section spring is less resilient than the circular-section spring which it can contain. F. R.

177. *Effect of a Blow.* A. W. Moseley and J. L. Bacon. (Amer. Soc. Mech. Engin., Trans. 27. pp. 605-609; Discussion, p. 609, 1906. Read May, 1906. Mech. Eng. 17. pp. 778-779, June 2, 1906.)—The authors used the following method for calibrating a 200-lb. steam hammer. Mild steel cylinders  $\frac{1}{2}$  in. diam.  $\times$   $\frac{1}{2}$  in. long, were compressed by the hammer falling from measured heights under its own weight only, and the potential energy corresponding to the height plotted against the amount of strain. Static tests showed that the potential energy required to produce a given strain under the hammer and to overcome friction was about 45 per cent. greater than the

work done in corresponding static tests. The energy of full blows under steam was taken from the curves, several crushers being used simultaneously. The order of agreement is shown by the following figures: With 4 crushers, aggregate effect of blow 616 ft.-lbs.; with 8 crushers, 489 ft.-lbs., and with 1 crusher, 675 and 705 ft.-lbs., in two cases, respectively, as measured upon the curve of static tests. In the discussion, D. S. Jacobus pointed out the importance of the velocity of blow—a factor to which the authors had not attached sufficient weight. F. R.

178. *Bending of Flat Plates of Boilers.* C. Bach. (Zeitschr. Vereines Deutsch. Ing. 50. pp. 1940–1944, Dec. 1, 1906.)—Two cases occur, (i.) where the plate has its ends free, and (ii.) where the ends are rigidly fixed. For a plate of length  $2l$ , breadth  $b$ , and thickness  $h$ , with ends free, the greatest bending moment ( $M$ ) and maximum tension ( $\sigma$ ) at the central section ( $A$ ) are given by  $M = \frac{p l^3}{8} = \frac{e b h^3}{8}$ , where  $p$  is the pressure per unit length. If the ends are clamped the bending moment at the ends ( $M_s$ ) =  $\frac{p l^3}{12} = \frac{\sigma_s b h^3}{8}$ , and at the centre  $M_A = \frac{p l^3}{24} = \frac{\sigma_A b h^3}{8}$ . At the point of inflection, which is 0.2887  $l$  from the centre,  $M = 0$  and  $\sigma = 0$ . A third case occurs where the ends are not clamped rigidly, when the bending moments depend on the end conditions. The author applies his theory to rectangular, elliptical, and circular plates. Some experimental tests are also described. A. W.

179. *Relation between Bending and Tensile Strength of Cast Iron.* W. Pinegin. (Zeitschr. Vereines Deutsch. Ing. 50. pp. 2029–2080, Dec. 15, 1906.)—The author's results confirm those of Bach, which show that the observed breaking moment of cast-iron beams is greater than that calculated from observed tensile and compressive strengths; but the author finds much greater differences than Bach found—ranging from 14.7 to 20.5 per cent. The specimens studied were of rectangular and I-section. F. R.

180. *Effects of Pickling and Baking Steel Wire Rods.* H. A. Baker and W. R. Lang. (Soc. Chem. Ind., Journ. 25. pp. 1179–1180, Dec. 31, 1906.)—The following examples illustrate the results of the authors' investigations into the condition of wire in the various stages of drawing:—

|                      | Tensile Strength,<br>lbs. per sq. in. | Elongation on<br>8 in.; per cent. | Contraction,<br>per cent. | Relative Resistance to repeated Bending through<br>a Constant Angle. |
|----------------------|---------------------------------------|-----------------------------------|---------------------------|----------------------------------------------------------------------|
| Before treatment ... | 59,700                                | 13                                | 66                        | 100                                                                  |
| After acid cleaning  | 59,700                                | 13                                | 44                        | 60                                                                   |
| After rusting .....  | 57,000                                | 14                                | 47                        | 56                                                                   |
| After lime coating   | 59,700                                | 14                                | 47                        | 57                                                                   |
| After baking .....   | 58,000                                | 13                                | 66                        | 99                                                                   |

In this case 11 per cent. sulphuric acid was used for 45 min. at 100° C., and the baking continued for four hours at 121° C. Further figures show the strength, &c., as the diameter is gradually reduced. Strong acid solution causes undue deterioration. Analysis indicates the improbability of the brittleness after pickling being due to the presence of sulphur in the metal, but the theory of the formation of a hydride of iron is said to be confirmed, though not as yet conclusively. F. R.

181. *Use of Special Steels for Riveting.* G. Charpy. (Comptes Rendus, 148. pp. 1156-1158, Dec. 24, 1906.)—Recalling the fact that the mechanical properties of steel are greatly affected by heat and mechanical treatment, the author points out that the process of riveting entails a definite form of such treatment. He has accordingly sought a variety of steel which should have the property of acquiring its highest mechanical properties under this specific treatment, and considers that this requirement is fulfilled by certain nickel-chrome steels. Specimens of these steels, as well as riveted joints constructed with it, have been tested at the Laboratoire des Ponts et Chaussées both under direct and alternating stresses. The conclusion is reached that "it seems that, without any special precautions, one may employ these rivets in structures under a working stress two and a half times greater than that permissible with ordinary rivets." The greatest advantage will be derived from such stronger rivets in long-span bridges and similar structures where the provision of adequate rivet area frequently leads to clumsy joints and greatly increased weight of members. W. Ros.

182. *Tension and Compression Tests of Concrete.* W. H. Burr. (Eng. Record, 54. pp. 648-644, Dec. 8, 1906.)—Gives results of tests of 1 : 2½ : 5 concrete, the greatest dimension of the stones (limestone) being up to 2½ in.; extensometer observations were made over 18 in. in the tensile specimens, and 12 in. in the case of compression specimens. The cross-sections were 6 × 6 in. and 5 × 5 in. respectively. The elastic limit in compression was between 600 and 700 lbs. per sq. in., but an elastic limit could not be detected in tension, either because it coincided with breaking load, or on account of the load not being truly axial. The stress-strain curves for tension were practically straight lines. The average ultimate strengths were 904 lbs. per sq. in. in compression, and 100 lbs. in tension. The average value of the coefficient of elasticity for compression was 2,764,000 lbs. per sq. in., and for tension 2,670,000. F. R.

183. *Conditions influencing Constancy of Volume in Portland Cements.* E. DeM. Campbell and A. H. White. (Amer. Chem. Soc., Journ. 28. pp. 1278-1303, Oct., 1906.)—Describes experiments on effects of variations of composition of neat cements upon volume-changes. The effect of magnesia depends more especially upon the form in which it exists in the cement than upon its total amount. With 8 per cent. of free MgO the expansion is too great to be safe. Magnesia forms a hydraulic cement, which is too weak, however, to be of any commercial value. Cement should always be aged before making up for work in which constancy of volume is of importance; although it becomes a quick-setting cement in time, yet later it reverts to a slow-setting condition again. F. R.

184. *Effect of Moisture on Wood.* (Eng. News, 56. p. 617, Dec. 13, 1906. Report of the Forest Service of the U.S. Dept. of Agriculture.)—It was found that proper drying greatly increases the strength and stiffness of all kinds of wood; e.g., red spruce dried at 100° C. is 400 per cent. stronger than when green. Upon absorbing moisture again, woods become weaker than when green. Air-dried wood, protected from the weather, and containing 12 per cent. moisture, is from 1·7 to 2·4 times as strong as when green. F. R.

185. *Flow of Steam through Nozzles.* L. Prandtl. (Phys. Zeitschr. 8. pp. 28-30, Jan. 1, 1907. Paper read before the 78. Naturforscherversammlung,



Stuttgart.)—From consideration of the waves set up by a shot passing through air the author deduces an expression for the angle which the waves set up in a gas passing through a nozzle make with the walls. Application is made to the theory of the compression thrust [see Abstract No. 796B (1906)], and to the contractions occurring in the issuing jet. Many illustrations are given and also numerous photographs, which show clearly the waves set up in the interior of the nozzle, also the compression thrust, and the modification of the angle of the waves in the issuing jet. These all seem to confirm the theory given. [See also Abstract No. 3 (1905).] A. W.

186. *Rolling of Ships.* O. Schlick. (Zeitschr. Vereines Deutsch. Ing. 50. pp. 1929-1934, Dec. 1, 1906.)—In this paper experiments are described on the prevention of the rolling of ships by the author's method, being a turbine mounted to act as a sort of gyroscope [see Abstract No. 1767B (1904)]. Experiments were carried out on a small steamer of displacement 57,000 kg., the length at water-line being 85.25 m., and the greatest breadth 8.6 m. The period of rolling when the turbine was stationary was 4.14 sec. The turbine was mounted amidships on hollow trunnions through which the steam entered and left, and the axis about which it swung was perpendicular to the central plane of the ship. Normally, the turbine wheel rotated in a horizontal plane. Several diagrams are given of the turbine, whose outside diameter was 1 m. and which made 1,600 r.p.m. The decrement of oscillation was noted when the turbine was at rest and when running, and the results show that the decrement is far greater when the turbine is running. With an initial displacement of  $15.5^\circ$  and the turbine at rest, the amplitude reached  $0.5^\circ$  at the end of 23 complete oscillations; with the turbine running and the same initial displacement the amplitude reached  $0.5^\circ$  at the end of 8 complete oscillations. For an initial displacement of  $10^\circ$  the corresponding numbers were 20 and 2. From his results the author concludes that equally good results might be obtained for larger vessels. A. W.

187. *Dependence of Gravity on Temperature.* L. Southern. (Roy. Soc., Proc. Ser. A. 78. pp. 392-403, Dec. 20, 1906.)—This effect is investigated by means of a special balance carrying, at one end of the beam, a light aluminium calorimeter containing refined paraffin oil in which is immersed a coil of fine Pt wire for heating purposes. The leads to the calorimeter pass together along the beam and are connected to mercury cups in a line with the central knife-edges. A similar vessel at the other end of the beam acts as counterpoise. The heating current was an alternating one of 0.2 to 0.35 amp., the temperature of the oil being raised only 4 or 5 degrees. The beam carried a mirror, and its motion was observed by a telescope, lamp and scale, the balance swinging in a case evacuated to a pressure of 1.6 to 5 cm. of mercury. The conclusion drawn from the experiments is that, within the limits of temperature used, no variation of weight occurs greater than 1 part in  $10^6$  for a rise of  $1^\circ\text{C}$ . The delicacy of the method is considered equal to that of Poynting and Phillips [see Abstract No. 2142 (1905)].

G. E. A.

188. *Radius of Molecular Forces.* K. Fuchs. (Ann. d. Physik, 21. 4. pp. 825-881, Nov. 27, 1906.)—The author infers that for a liquid the quotient (surface tension)/(latent heat of evaporation) is of the order of the radius of action of the molecular forces. Or, more exactly,  $A_1/A_2 = 8\pi/16$ , where  $A_1$  is

the surface energy per unit area,  $A$ , is the heat of evaporation in work units per unit volume, and  $r$  is the radius of influence. But, on inserting numerical values in this formula, the  $r$  comes out much less than the radius of the molecule. E. H. B.

189. *Surface Concentration.* S. R. Milner. (Phil. Mag. 18. pp. 96-110, Jan., 1907.)—In a pure liquid, where the surface tension is rigorously uniform, lasting films do not exist, since the slightest local disturbance of equilibrium would make them collapse. A capability of local variation in the surface tension is therefore essential to the stability of a film. In this paper the author gives results of observations which throw light on the mechanism by which the stability of a film is maintained. The supposition is made that in the thin surface-film which is the seat of the capillary forces, the concentration of the solute is different from what it is in the interior of the solution. The actual concentration in the surface-film is indeterminate, in the absence of any knowledge as to how it varies with the distance away from the surface; but the whole excess of the solute associated with the surface can be readily calculated. It is shown that  $dr/dc = -iRT(\sigma/c)$ , where  $\sigma$  is the "surface-excess," i.e., the number of gm.-mols. of the solute associated with each sq. cm. of the surface which are drawn out from the interior and made ineffective on the osmotic pressure;  $r$  is the surface tension,  $c$  the concentration, and  $i$  the ratio of the molecular lowering of the freezing-point (lowering per gm.-mol. per litre) to the normal lowering, 1.86. In all inorganic solutions so far measured the surface tension increases linearly with the concentration, so that  $dr/dc$  is positive and constant; hence  $\sigma$  is negative and  $\sigma/c$  is constant. i.e., there is a defect of salt in the surface-film of an amount proportional to the concentration. For  $n$  NaCl solution  $\sigma = -4.09 \times 10^{-11}$  gm.-mol. per sq. cm., which is equivalent to a defect of 0.024 mgm. per sq. m. In several organic solutions, however, the surface tension is less than that of water, and there is consequently an excess of solute in the surface. Acetic acid is cited, for which  $\sigma = 8.8 \times 10^{-10}$  gm.-mol. per sq. cm., or 0.20 mgm. per sq. m. in a normal solution. The existence of the surface-excess was verified experimentally for sodium oleate, and a rough estimate of its value made. In the latter part of the paper the above conceptions are applied to some results on the conductivity of soap-films by Reinold and Rücker, and to the explanation of the manner of thinning of films, and of the formation of the black spot.

A. W.

190. *Thermodynamics of the Atmosphere.* VI. and VII. *Waterspout seen off Cottage City, Mass., in Vineyard Sound on Aug. 19, 1896.* F. H. Bigelow. (Monthly Weather Rev. 84. pp. 807-815, July, and pp. 860-870, Aug., 1906.)—Three waterspouts were observed soon after noon, all three starting apparently from the same part of a cloud and forming phases of the same phenomenon. The first was visible from 12.45 to 12.58, the second from 1 to 1.18, the third from 1.20 to 1.27. The author visited the spot in the subsequent September and ascertained the exact positions of the observers and photographers, so that measurements could be made. The paper reproduces the reports of the eye-witnesses, W. W. Neifert, W. B. Dwight, and others, and some of the photographs taken by W. Coolidge, J. N. Chamberlain, E. K. Hallet, and others. The computed dimensions of the waterspout, which changed rapidly in appearance, of course, are: Diameter at the water surface 78 m., at foot of cascade 220 m., at middle of vortex tube 44 m., at face of cloud 256 m., length of tube 1,097 m., height of top of the cloud 4,877 m. There are three meteoro-

logical observatories, the Nantucket Observatory being a station of the first order, near the locality of the waterspout. The temperature at the base of the waterspout was  $87.5^{\circ}$  F., being the maximum of the day, but the lower strata were drier than on any day of that month. Referring to his exposition in the International Cloud Report the author proceeds to an elaborate computation of the air-pressure, temperature, vapour tension, and heights for the  $\alpha$ ,  $\beta$ ,  $\gamma$ ,  $\delta$  stages. The  $\alpha$  stage extended from the sea-level up to the base of the cumulus cloud, the  $\beta$  stage further up to 9,200 ft. above sea-level, the  $\gamma$  stage 246 ft. further up, and the  $\delta$  stage up to 16,200 ft. In the  $\alpha$  stage dry air and invisible water were mixed; in the  $\beta$  stage there were water-drops in addition to those constituents; in the  $\gamma$  stage the water was changing to ice at freezing-point; the  $\delta$  stage is the snow stage. The powerful vertical convection currents which must have prevailed cannot be accounted for by overheating of the surface by solar radiation, of which there was no indication in this case. A well-defined area of high pressure was pushing its south-eastern portion over Vineyard Sound, accompanied by a fall of temperature of  $15^{\circ}$ . The upper, cold air was moving eastward in advance of the lower, warmer strata, in which the cold air followed a few hours later; and this abnormal cooling and advance of the higher strata produced the vertical convection, and is also the primary cause of most of the phenomena classified as thunderstorms, tornadoes, and hurricanes. H. B.

191. *Results of the Franco-American Expedition to Explore the Atmosphere in the Tropics.* A. L. Rotch. (Amer. Acad., Proc. 42. No. 14. pp. 263-272, Dec., 1906.)—Particulars of the joint experiments arranged by Teisserenc de Bort and the author, for June to Aug., 1905 [see Abstract No. 22 (1906)], and subsequently, to meet Hergesell's criticisms [Abstract No. 1851 (1906)], for Feb., 1906. Clayton flew kites from the *Romanic* in crossing from Boston to Gibraltar; Maurice and Clayton then cruised in the *Olaría*, and also made observations on the Peaks of Teyde (Teneriffe) and Fogo (Cape Verde Islands), on the Azores, and off Corunna (Spain), during the solar eclipse. Kites, balloons carrying instruments, pilot balloons, and cloud observations were used, and pressure, temperature, and relative humidity determined; the results are tabulated. In the northern edge of the NE. trade, between Lat.  $86^{\circ}$  and  $84^{\circ}$  N., the temperature falls rapidly with height ( $7.8^{\circ}/1,000$  m.), especially in the first 500 m. ( $0.92^{\circ}/100$  m.); the wind direction, generally NE., changes little with altitude, but the speed increases. The same features are repeated south of the NE. trade, Lat.  $10^{\circ}$  N. (only two observations). Within the trade-wind zone, Lat.  $81^{\circ}$  to  $15^{\circ}$  N., the vertical distribution of temperature and humidity is quite different. Near its origin the trade wind has the character of a descending current, nearer the equator, south of  $24^{\circ}$  N., of an ascending current. The temperature falls by  $0.58^{\circ}$  in the first 500 m., and rises by  $0.56^{\circ}$  in the next 500 m. Above the surface trade, there is a current, 2,000 m. in depth, varying between NE. and NW., but coming always from a direction to the left of the lower wind when facing; this current is extremely warm, and faster than the surface wind. Above 8,000 m. the wind is from E. in the equatorial regions, from S. or SW. between Lat.  $15^{\circ}$  and  $80^{\circ}$  N. At great heights the winds are from N. and NW. between Madeira and the Azores (beyond the trade zones). As regards vertical distribution of temperature and humidity in these regions, the author agrees with Hergesell. South-west of the Canaries, Lat.  $25^{\circ}$  to  $28^{\circ}$ , Maurice and Nilsson found in Feb., 1906, the southerly anti-trade between 8,000 and 4,000 m. H. B.

192. *Meteorological Optics.* R. W. Wood. (Monthly Weather Rev. 34. pp. 357-359, Aug., 1906.)—Reviewing the recent volume on meteorological optics by J. M. Pernter, the statement that the spiculae or ice crystals in falling take up positions of *minimum* resistance is directly challenged, the true position being that of *maximum* resistance to the medium through which the particle is falling. Apart from this the book is extremely complete, embracing full descriptions of halos, parhelia, rainbows, &c., and, in fact, all the phenomena due to the reflection, refraction, and diffraction of light by clouds, snow, or ice crystals, raindrops, &c., suspended in the air. Various interesting experiments on abnormal rainbows by the reviewer are included. [See Abstract No. 106 (1906).] C. P. B.

193. *Amount of Carbon Dioxide in Sea Air.* R. Legendre. (Comptes Rendus, 143. pp. 526-528, Oct. 8, 1906.)—Cruising on the *Pétrel* off the Brittany coast, in Aug. and Sept., the author found from 32 to 38 litres of CO<sub>2</sub> in 100 m.<sup>3</sup> of air; including two evidently erroneous observations of 38 and 39, he obtains the average 33.5 litres. His apparatus of Albert-Lévy and Pécoul only contained 5.5 litres of air, but the titration of the caustic soda with acetic acid could at once be made on board. The figures are a little higher than those found simultaneously at the Montsouris Observatory, Paris. Previous determinations, made in different parts of the Atlantic, are: Lewy (1847) from 3.3 to 5.77 parts of CO<sub>2</sub> in 10,000; Schulze (Baltic, 1873) 2.25 to 3.44; Müntz and Aubin (1884) 2.49 to 2.77. H. B.

194. *Upheaval of the Sea-coast by Earthquakes.* T. J. J. See. (Nature, 75. p. 224, Jan. 3, 1907.)—According to H. D. Curtis, the harbour of Valparaiso is now 10 ft. less deep than it was before the earthquake of Aug. 18, 1906; the movement seems to have been mainly vertical. In reporting (Bull. Geolog. Soc. of America, May, 1906) on the changes of level at Yakutat Bay, Alaska, due to the earthquakes of Sept. 3 to 20, 1899, Tarr and Martin point out that the coast has been raised for more than 100 miles, the maximum movement in Disenchantment Bay amounting to 47½ ft.; uplifts of 7 to 20 ft. were common; a few subsidences were also observed. The author regards these vertical movements in the light of Suess' views ("The Face of the Earth"), and as incompatible with the assumption of an entirely solid earth. In commenting upon the observations of Tarr and Martin, J. M. remarks that similar movements took place during the Columbia and San Francisco earthquakes of Jan. 31 and April 18, 1906. The masses involved in such earthquakes, of which we have about 60 every year, may be estimated at 1 or 2 million cubic miles of rocky material. H. B.

195. *Seismic Tremors.* A. Schuster. (Phys. Zeitschr. 8. pp. 51-53, Jan. 15, 1907.)—In recent works on the propagation of earthquake waves, importance has been attached to the direction of the first vibration of the earth's surface, it being thought possible to determine thereby the wave normal. The matter is here considered, and the author concludes that the first motion can only be a vertical one, provided that the waves in question are purely of the condensational type. But owing to the probable changes in the elastic constants of the earth's crust from point to point it is doubtful whether the existence of purely condensational waves can be legitimately assumed. Thus, through local irregularities, other motions might occur, but it is not held safe to base any determination upon them. E. H. B.

196. *Temperature of the Moon.* W. W. Coblentz. (Phys. Rev. 28. pp. 247-248, Sept., 1906.) Abstract of paper read before the Amer. Physical Soc.)—Extending Nichols's discovery for quartz, the author shows that various common silicates, reflecting only diffusely in the spectral region of shorter wave-length than  $8\mu$ , have bands of metallic reflection from  $8.5$  to  $10\mu$ ; and from this deduces that "the earth and moon may be considered selectively reflecting surfaces with a band of metallic reflection from  $8.5$  to  $10\mu$ ." Hence, he argues, "the radiation from the sun is so much more intense than that of the moon that, with a reflecting power of 50 to 90 per cent., at  $8$  to  $10\mu$  one would expect the amount of reflected energy to be at all times greater than the direct radiation from the moon." On the assumption that the extreme infra-red maximum in the energy curve of the lunar spectrum is due to metallic reflection, he arrived at the result that "Langley's first conclusion of a lunar temperature of  $-225$  C. again obtains." F. W. Very. (Astrophys. Journ. 24. pp. 351-354, Dec., 1906.)—Very gives reasons for disputing Coblentz's conclusions, and the following are extracts from his objections: 1. If the moon reflected specularly there should be a maximum of heat in the lunar image in the first quadrant at a point  $0.7$  of the distance from the centre of the disc to the west limb. Instead of this the maximum heat is at the west limb, where it should be if the moon radiates as a hot body, heated by the sun. 2. The spectral energy-curve of the moon's radiation is not a band from  $8.5$  to  $10\mu$ , but a continuous spectrum. After elimination of an obviously reflected portion, of wave-length shorter than  $8\mu$ , the lunar-energy curve, when corrected for absorption by the earth's atmosphere, exhibits a similarity in form and extent to the spectral energy-curve of a heated body. It is true that the observed lunar-energy curve has its maximum in the region of the bands discovered by Nichols and Coblentz, but this curve is obtained after enormous atmospheric absorption in the region of the great water bands between  $5$  and  $8\mu$ . These bands transform what is really a maximum into an apparent minimum. The restored curve is that of bodies not much below the temperature of boiling water. Again, measurements at points in the lunar spectrum beyond  $10\mu$ , where atmospheric absorption does not much interfere, show substantial agreement with the radiations of screens containing hot water. 3. The moon reflects diffusely about one-eighth of the solar rays between  $0.8$  and  $8.0\mu$ , giving a spectral energy-curve of reflected radiation about half as high as the observed extreme infra-red maximum. But the energy in the solar spectrum at  $8.5$  to  $10\mu$  is hardly a hundredth of that at  $1\mu$ . The author suggests, with a view to throwing light on the question, that search should be made for a small solar image due to specular reflection of rays of  $8.5$  to  $10\mu$  wave-lengths, at a point at a distance from the centre of the moon's disc  $V = \cos \frac{1}{2}$  moon's elongation, by means of a delicate heat-measuring instrument. 4. It is not true that the drop in lunar radiation during a lunar eclipse "from a maximum to a minimum in about 1.5 hours" would seem to indicate that the observed radiation is reflected from the sun, since the lapse of time is so short. Experiments on heated rocks show that a surface layer may cool quickly while the interior of the mass is still hot. A few hours of sunshine replenish the thin layer cooled, though it takes two weeks of sunshine to produce the high temperature of the full moon. W. W. Coblentz (Phys. Rev. 24. pp. 121-122, Jan., 1907.)—Coblentz withdraws his deductions. A. E. van den Bos. (Konink. Akad. Wetensch. Amsterdam, Versl. 15. pp. 218-226, Oct. 10, 1907.)
197. *The Relation between the Spectra and Colours of the Stars.* A. Pannekoek. (Konink. Akad. Wetensch. Amsterdam, Versl. 15. pp. 218-226, Oct. 10,



1906. Proc., 9. pp. 292-302, Nov. 22, 1906.)—In a former paper [see Abstract No. 1675 (1906)] the author was met by the difficulty that we do not know where, in the series of star spectra of various types, to look for the highest temperature, or greatest luminosity, the necessary spectral photometric measures being wanting. The present investigation is an attempt to solve the question by using star colour observations. The colours have been found to succeed one another in a certain order with increasing temperature, and, as it happens, the colours produced by increase of atmospheric absorption follow about the same order. Hence it is possible to represent star colours by a scale consisting of a single series of figures, such as that of Schmidt, in which 0 = white, 4 = yellow, and 10 = red. A list on Schmidt's scale of the colours of all stars down to the 5th magnitude has been published by Osthoff in *Astronom. Nachr.* 158. Nos. 3657-58, 1900. Assuming the temperature to be highest where the light is whitest, the author compares stars common to Osthoff's colour list and Miss Maury's catalogue of stellar spectra, in order to find the spectral class of the whitest stars. Two modifying influences are allowed for, viz., brightness, and altitude above horizon. To find the first, the stars are arranged in order of magnitude in each spectral group, with their colour numbers appended, and means are taken, from which a relation between brightness and colour number is derived. The colour is found to vary with brightness more rapidly for brighter than fainter stars in all classes except the red stars. The explanation may be sought in the loss of colour perception in fading light, the perception for red being the most persistent. The second correction, for altitude, is only important in the case of a few southern stars, but an attempt is made to allow for it by taking declination as an index to altitude, and calculating deviation of observed colours from mean values. The Maury *c* and *ac* stars, L (bright line), P (peculiar spectra), and C (composite spectra) are excluded in the investigations. The author's results, when tabulated after applying the above corrections, show a fall of colour-number in the first Maury classes, a minimum (*i.e.*, greatest whiteness) between the 4th and 5th class, and then a continual rise, class VIII. agreeing best in colour with classes I. and II. In other words, the maximum of radiating power lies among the stars directly following on  $\gamma$  Orionis in order of evolution ( $\mu$  Aurigæ,  $\alpha$  Herculis, &c.). The following is an abridged list of the mean colour-numbers corresponding to the spectral classes:—

| Maury Class.   | Schmidt Colour No. | Maury Class.    | Schmidt Colour No. |
|----------------|--------------------|-----------------|--------------------|
| I.-III. ....   | 2.85               | XIII.-XIV. .... | 4.68               |
| IV.-V. ....    | 1.87               | XV. ....        | 5.48               |
| VI.-VIII. .... | 2.80               | XVI.-XIX. ....  | 6.66               |
| IX.-XII. ....  | 8.20               |                 |                    |

In the concluding portion of the paper the two influences, radiating power and atmospheric absorption, which determine the colours of the self-luminous celestial bodies, are subjected to an abstract theoretical calculation. The radiating body is assumed to be perfectly black; and in calculating the absorption, selective absorption in lines and bands is neglected. König's measures of the relative quantities of the elemental colours red, green, and blue in sunlight are used. If for any other source of light the ratio of the brightness to that of sunlight is known, we can calculate the quantities of red, green, and blue in this second source. From the results it appears that the above two different influences, though producing similar colours, correspond to an entirely different decrease of brightness; atmospheric absorption being

more apt to redden, decrease of temperature to fade the light. The colouring due to an absorption by 1.05 atmos. is almost equal to that brought about by a diminution of degree of glow of  $1/8$ ; but the brightness is reduced in the former case to 0.788, and in the latter case to 0.257, of its original value. Therefore it is impossible to derive the radiating power from the colour only, as we do not know to what degree each of the two influences, temperature and absorption, is at work in the different spectral classes. Accurate spectral-photometric measures may one day enable us to separate the two influences, for they give a different distribution of intensity over the spectrum. A. E.

198. *Lunar Crater Linné.* Wirtz, W. H. Pickering. (Astronom. Nachr., No. 4141. Nature, 75, p. 231, Jan. 8, 1907. Abstract.)—Wirtz points out that an apparent enlargement of the white spot surrounding Linné may be produced by the interposition of a shade-glass between the eye-piece of the telescope and the eye, and that the variations of the crater might be due to the diminution of light. Pickering, however, says that while this apparent enlargement undoubtedly exists, its magnitude is much less than that recorded by the eclipse observers. Further, the observations indicate that the white spot was larger after the passing than at an equal time before the passage of the earth's shadow, whereas if the enlargement were merely subjective it should not last after the re-illumination. C. P. B.

199. *The Relation between Stellar Spectral Types and the Intensities of certain Lines in the Spectra.* S. Albrecht. (Astrophys. Journ. 24, pp. 833-844, Dec., 1906.)—In connection with the measurement of spectrograms taken at the Mills Observatory in Chile, an investigation of spectrum lines was undertaken, with the view of determining whether any of the lines show a progressive shift from spectral type to type. Several lines were found which undergo such a change. An examination of Rowland's tables shows that, in most cases studied, lines apparently single are really blends of two or more close components. The nature of the variations found is such as to indicate varying intensities of the same component, rather than presence or absence of different components in the different types. The data were compared with a list of sun-spot lines for the region covered by the southern Mills plates [Abstract No. 2018 (1906)] and the preliminary results, which depend, not only upon the appearance of the lines but primarily upon measures of their positions, are given in the paper. Some 25 lines or blends are considered of wave-lengths between  $\lambda 4258.219$  and  $\lambda 4468.668$ . The investigation was limited to stars of classes F to Mb of the Harvard classification, in which the sun is of class G. The results strongly indicate that the physical conditions in the stars, as we pass from the F to the Mb class, vary roughly in the same direction as from the sun to the sun-spots. No one type has been found in which the conditions are exactly the same as in the sun-spots, though an early K class is probably nearest to it. In the Mb class the relative intensities of the lines have gone far beyond what they are in the sun, while in the F class they precede the condition in the solar spectrum. A large number of lines not included in the sun-spot list change greatly in intensity and appearance as we proceed from the F to the Mb class, the change being frequently prominent even from the G to the K class. Among the most striking of these are the Cr lines,  $\lambda 4254.6$  and  $\lambda 4274.9$ , which become very strong, wide, and diffuse as we follow the scale of stellar types. A few cases of contradictory evidence have also been found, in which the residuals show a decided shift in the opposite direction to that which would be expected from the intensities assigned to

the components in sun-spots. Among these the line  $\lambda 4485.2$  may be mentioned. In one or two cases, again, the residuals tend to show an oscillation of the line, which shifts in one direction from the F to the G class, and in the opposite direction from the G to the Mb class. Some of the observed differences between sun-spots and stellar K types may be due to the fact that in the stars the physical condition is the average condition of their entire atmospheres, while in sun-spots effects may be altered by overlying layers of gases and vapours or by other local circumstances. "Nevertheless the similarities are sufficiently striking to promise much for this line of study."

A. E.

**200. Systematic Stellar Motions. A. S. Eddington.** (Roy. Astronom. Soc. Monthly Notices, 67, pp. 84-68, Nov., 1906. Nature, 75, p. 182, Dec. 20, 1906. Abstract.)—The proper motions of the stars in the Greenwich-Groombridge Catalogue are discussed on the assumption that they may be considered as belonging to two defined systems. The theory of Kapteyn is quantitatively confirmed, evidence being adduced of the existence of two drifts having relative motions. Analysis of the results enabled the author to state that the stars of drift I. have a common velocity, relative to the sun, away from a point near  $RA = 18h.$ ;  $Decl. + 18^\circ$ ; the apex of drift II. is near  $RA = 7h. 80m.$ ;  $Decl. = + 58^\circ$ . The velocity of the first drift relative to the sun is much larger than that of the second, in the ratio 17.5 approximately. From an investigation of the magnitudes of the proper motions there appears to be no appreciable difference in the mean distances of the stars of the two drifts.

C. P. B.

**201. Nova Vela. E. C. Pickering.** (Nature, 75, p. 187, Dec. 6, 1906. From Circular No. 121 of the Harvard College Observatory.)—The star was discovered by Miss Leavitt, on a plate taken with the 1-in. Cooke lens on Dec. 5, 1905, and also on fourteen plates between that date and June 29, 1906. Its position is—

$RA = 10h. 58m. 20s.$ ;  $Decl. = - 53^\circ 50' 9''$  (S).

As determined from the Harvard plates, the greatest magnitude attained by the Nova was 9.72. There were considerable fluctuations of light during the period covered by the observations.

C. P. B.

#### REFERENCES.

**202. Apparatus for Study of Mechanism.** (Engineering, 82, pp. 858, 859, and 861, Dec. 28, 1906.)—This paper gives a description of apparatus designed by W. H. Newman to facilitate the study and to illustrate the properties of such mechanisms as valve gears, and all forms of link motion. The parts employed are comparatively few in number and very easily interchanged or adjusted, so that the effect of varying the proportions of (say) a link motion can be readily obtained.

A. W.

**203. Venturi Tube. E. P. Coleman.** (Amer. Soc. Mech. Engin., Proc. 28, pp. 391-405, Nov., 1906; Discussion, pp. 956-958, Jan., 1907.)—This paper describes a series of experiments on Venturi tubes which prove that, to a degree of accuracy sufficient for commercial purposes, the Venturi tube is an instrument of convenience and precision when used for measuring the quantity of air or gas (and steam, when not too wet) flowing through it.

A. W.

204. *Friction.* **A. Lampa.** (Akad. Wiss. Wien, Sitz. Ber. 115. 2a. pp. 871-880, June, 1906.) From the I. phys. Inst. d. k.k. Univ., Wien.)—Describes researches, with theory, on the coefficient of friction between a rod and its two supports, as they are moved inwards towards the centre of gravity. **A. W.**

205. *Elasticity Theory: Application to Static Problems.* **K. Wieghardt.** (Verein zur Beförd. des Gewerbelebens, Verh. No. 8. pp. 139-176, March, 1906.)—A mathematical paper in which the views of the author and F. Klein (Arch. Math. u. Phys. 8. No. 1, p. 1) are applied. **L. H. W.**

206. *Determination of Elastic Constants of Iron-Glance.* **W. Voigt.** (Ann. d. Physik, 22. 1. pp. 129-140, Dec. 28, 1906.)—By experiments of bending and twisting bars cut from iron-glance received from Christiania its elastic constants were calculated. **E. H. B.**

207. *Stability of Submarines.* **W. H. S. Garnett.** (Cassier, 31. pp. 235-241, Jan., 1907.)—Discusses some points left untouched in previous papers [see Abstract No. 1530 (1906)].

208. *Theory of Gravitation.* **A. Wilkens.** (Phys. Zeitschr. 7. pp. 846-850, Nov. 15, 1906.)—The theory of Lorentz gives inconsistent results when applied to the motion of the planets by F. Wacker [Abstract No. 1185 (1906)]. The author gives his own treatment and shows that this inconsistency does necessarily arise. **S. G. S.**

209. *Theory of Surface Forces.* **G. Bakker.** (Phil. Mag. 12. pp. 557-569, Dec., 1906.)—A mathematical paper. [See also Abstract No. 61 (1906).]

210. *Semi-diurnal Variation in Temperature and Air-pressure.* **R. Börnstein.** (Akad. Wiss. Wien, Sitz. Ber. 115. 2a. pp. 881-904, June, 1906.)—Additional evidence in support of the author's views as to the reality of this variation [see Abstract No. 2137 (1904)].

211. *Meteorological Observations in Western Australia, 1904.* **W. E. Cooke.** (Government Astronomer's Report to Colonial Secretary, pp. 5-144, 1906.)—[See Abstract No. 1040 (1906).]

212. *Earthquake Registration at Göttingen.* **G. Angenheister.** (Gesell. Wiss. Göttingen, Nachr., Math.-phys. Klasse, 4. pp. 357-375, 1906.)—Discussion of earthquakes registered at Göttingen during 1906, with comparisons of times of same shocks recorded elsewhere, giving velocity of propagation of seismic wave and other data. **C. P. B.**

213. *Improvements in Seismographs with Mechanical Registration.* **C. F. Marvin.** (Monthly Weather Rev. 34. pp. 212-217, May, 1906.)

214. *The Zodiacal Light.* **A. Searle.** (Monthly Weather Rev. 34. pp. 408-410, Sept., 1906.)—Comments on Hall's paper, with suggestions [see Abstract No. 1537 (1906)].

215. *Periodicities of Sun-spots.* **A. Schuster.** (Roy. Soc., Phil. Trans. 206. pp. 69-100, June 6, 1906.)—The full paper corresponding to Abstract No. 679 (1906).

216. *Harmonic Analysis of Sun-spot Numbers.* **S. Hirayama.** (Physico-Mathematical Soc., Tokyo, Proc. 3. 9. pp. 159-164, Nov., 1906.)—Analysing the new values of sun-spot frequencies published by Wolfer in 1902, the author finds that in addition to the principal period of 11.13 years there are important periods of 5.57 and 8.35 years to be considered. C. P. B.

217. *Formation of the Solar System.* **S. T. Preston.** (Phil. Mag. 12. pp. 570-576, Dec., 1906.)—Discussion of an old paper by Herbert Spencer on the possibility that the "flow" phenomena, which we know to apply to practically all substances, is sufficient to account for the present shape of the earth and other bodies of the solar system without any assumption of original fluidity. Following up this idea, the formation of bodies by accretions of meteorites is developed, as outlined by Darwin at the British Association meeting in South Africa. C. P. B.

218. *Orbit of Comet Holmes and Perturbations of its Motion.* **H. J. Zwiers.** (Konink. Akad. Wetensch. Amsterdam, Versl. 15. pp. 372-382, Dec. 5, 1906. Proc., 9. pp. 414-424, Dec. 21, 1906.)—[See Abstract No. 874 (1906).] C. P. B.

219. *Stars with Variable Radial Velocities.* **Hartmann.** (Astronom. Nachr., No. 4135. Nature, 75. p. 137, Dec. 6, 1906. Abstract.)—From spectrograms taken at the Potsdam Observatory the author has discovered that the two stars R.Z. Cassiopeie and  $\gamma$  Cassiopeie have variable radial velocities. In the case of  $\gamma$  Cassiopeie the velocity ranges from +3.1 km. (1900, Sept. 21), and -19.3 km. (1901, Sept. 27). C. P. B.

220. *Secular Motion of Jupiter's Fifth Satellite.* **H. Struve.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 44. pp. 790-810, 1906.)—Discussion of the observations of the fifth satellite of Jupiter made at Yerkes by Barnard. C. P. B.

221. *System of 61 Cygni.* **Barnard.** (Astronom. Nachr., No. 4128. Nature, 75. p. 40, Nov. 8, 1906. Abstract.)—Discussion of measures made on 144 nights from Aug. 7, 1900, to Nov. 12, 1904. The determinations were undertaken with the intention of testing Wilsing's hypothesis concerning the existence of an unknown dark body in the system of 61 Cygni. Barnard's results do not confirm Wilsing. The distance between the two components does not appear to be affected by any periodical variation. C. P. B.

222. *Wave-lengths in Stellar Spectra.* **H. E. Lau.** (Astronom. Nachr., No. 4134. Nature, 75. p. 182, Dec. 20, 1906. Abstract.)—In double star observations it is important to know not only the relative brightness of the components, but also the effective radiations according to their wave-lengths. Lau has determined this for seventy stars, employing Comstock's interference method. C. P. B.



## LIGHT.

**223. Spectrograph.** K. Siegl. (*Zeitschr. Instrumentenk.*, Beib. 21, p. 201, Nov. 1, 1906.)—This spectrograph is designed to combine high dispersive and light power with special sensitiveness to green, being intended for photographing changes occurring in the spectrum lines of a glowing gas under the influence of pressure, heat, or electric and magnetic forces. For the investigation of fluorescence spectra, flame spectra of alkalis, &c., high sensitiveness in the green is often desirable. The instrument is furnished with two prisms of 60°, made of the densest Jena normal glass, thallium flint. The optical constants of the prisms are: Index for the D line  $n_D = 1.8049$ ,  $v_D = 25.4$ , variation of  $n$  from C to F = 0.08168, from C to D = 0.00884, from D to F = 0.02284. The prisms are placed at minimum deviation for F. The focal length of the collimator is 20 cm. The camera has an objective of thallium flint like the prisms, which, as pointed out by Hartmann, gives a spectrum in a plane inclined to the mean direction of the beam, thus avoiding the use of a curved film [see Abstract No. 86 (1905)]. Two such objectives of 25 and 50 cm. focus, are provided, which may be used together or separately. The plate-holder can be replaced by a micrometer microscope for visual work. The instrument is well adapted for the study of the aurora. A. E.

**224. Automatic Prism Stand for Minimum Deviation.** F. Löwe. (*Zeitschr. Instrumentenk.* 26, pp. 362-368, Dec., 1906. Communication from the Optical Works of C. Zeiss.)—The main feature distinguishing the new device from its predecessors is the substitution of a piston-in-cylinder motion for the usual pin-and-slot arrangement which soon becomes unreliable with wear. The following is a sketch of the principle. The automatic prism-table must rotate at half the rate of the telescope and in the same direction. Let C be the centre about which the telescope revolves, C being the point where the axes of the collimator (K), and telescope (F) meet when produced. Suppose a circle, having C as centre, to cut CK in A, and CF in B. Then, when the telescope, i.e., the radius CB, moves through any angle, the chord AB moves through half that angle. In the author's arrangement the prism-table is pivoted at A, a point in the prolongation of the collimator axis; and has a hollow cylinder attached to its under surface along the chord AB. A steel wire rod slides in the cylinder, while its outer end, bent at right angles, forms a pivot fitting into a vertical hole B in the prolongation of the telescope. To prevent the rod turning in the cylinder, both are flattened along one side. The revolving table is supported on three smooth steel knobs, which, when the telescope is moved, glide on a horizontal plate attached rigidly to the base of the spectroscope. Upon the revolving table in turn stands the little prism-table proper, which can be adjusted by means of three levelling-screws. The device, like all of its kind, is more especially useful for work in the invisible region of the spectrum. A. E.

**225. Equatorial Twin Telescope at the Radcliffe Observatory, Oxford.** (*Engineering*, 82, pp. 819-822, Dec. 21, 1906.)—A very detailed description, fully illustrated, is given of this instrument, which was constructed by Grubb, and erected three years ago. The dome and tower are included in the

account. The twin comprises a photographic refractor, of 24 in. aperture, and a visual refractor of 18 in. aperture, both having a focal length  $22\frac{1}{2}$  ft. The upper end of the polar axis is fitted with an arrangement for relief of friction. When the telescope is 6 hours off the meridian, a balance-weight exerts, by means of a lever, an upward force relieving the Y bearings of the pressure of the declination axis. When the telescope is in other positions the weight produces a pressure not purely upward but at various angles, and the force of the lever is exerted more on one of two rollers than on the other, just as required. An improved form of Grubb's differential device for increasing or diminishing the rate at which the driving worm rotates is fitted, giving a reasonably rapid motion as well. The visual 18-in. telescope is used for micrometric work when not required as a guider, and the bi-filar micrometer for use with it presents several points of interest. Both screw-heads or drums are furnished, in addition to the usual divisions, with raised divisions cut in steel for printing a record on a travelling tape. The tape is kept pressed against the drum by a linoleum pad, but an ingenious device prevents this pressure being communicated to the screw. A. E.

226. *Spectrograph for Infra-red.* H. Lehmann. (Zeitschr. Instrumentenk. 26. pp. 858-860, Dec., 1906.)—With this instrument, the objectives of which are specially corrected for the infra-red rays, the author has succeeded in photographing the spectrum as far as  $2\mu$ , by means of the phosphorographic process, which depends on the property possessed by the infra-red rays of extinguishing phosphorescence. Objectives of ordinary construction do not give sufficient definition beyond about  $0.9\mu$ . The prisms used in connection with the new spectrograph are of strongly refracting flint. Ordinary diffraction gratings, with about 600 lines to the mm. are here quite useless, the grating interval being smaller than the wavelength; but a coarse wire grating has been tried in later experiments. As phosphorescent medium, the author pins his faith to the Sidot-screen (zinc sulphide), which phosphoresces green, and has a wide range of action. The sulphide, in a finely pulverised state, is pressed by means of a glass plate into the bed of a film of some transparent medium. The screen so formed is excited in blue light for  $\frac{1}{4}$  to  $\frac{1}{2}$  min., and then immediately exposed to a spectrum for 1 or 2 min. It is then quickly placed in contact with a photograph plate sensitive to green (such as Perutz's Perorto plate), which, after at most two hours, is developed in the ordinary way. The proper ratio of the times for excitation and exposure must be carefully ascertained by trial, as the relative intensity of the phosphorescent and infra-red radiations has a great influence on the result. The glasses used for the infra-red objectives were Steinheil-Flint, No. 48, and Steinheil-Crown, No. 218, the indices being respectively 1.577 and 1.521. They were selected merely for their clearness. The transparency of glass is quite sufficient for the end in view, its infra-red absorption band only beginning at about  $8\mu$ . The dispersion was tested by the aid of formulæ connecting the intervals between three lines, of which two are in the visible and one in the invisible region. The processes of calculating the infra-red indices, the chromatic curves, and finally the forms of the objectives, are described. The focal length decided on is 860 mm., with aperture 40 mm. The region corrected for extends from about  $589$  to  $1,600\mu$ , the chromatic curve having its vertex at  $1,000\mu$ . This ensures that portions of the visible and invisible red regions will be in sharp focus simultaneously, which lightens the task of adjustment. The length of the above spectrum interval on the plate is about 55 mm. The

method adopted by the author was previously used by Lommel and Fomm in examining the solar spectrum as far as  $980 \mu$ , but the data concerning their optical system are not precisely known. They used Balmain's luminous paint (calcium sulphide), which is phosphorescent in blue light, and has not such an extensive field of action as the Sidot screen.

**227. Fresnel's Reflection Formulae.** L. Meitner. (Akad. Wiss. Wien, Sitz. Ber. 115. 2a. pp. 869-899, June, 1906. From the II. phys. Inst. d. Univ., Wien.)—Rayleigh has described an experiment which depends on the reflection at the interface of two media whose relative index of refraction for yellow light is unity. The present author here gives a theoretical and an experimental examination of the matter, the two being in accord and showing that, so far from being any contradiction of Fresnel's reflection formulæ, this phenomenon only adds a further confirmation of their validity. A mixture of carbon disulphide and benzol was used so as to give for yellow light the same index of refraction as the glass plate used. The chief result of theory and experiment may be stated thus: If the relative refractive index for yellow light is precisely unity, that for red light greater and for blue light less than unity, then for a fairly oblique incidence total reflection occurs for the blue and violet light. As the incidence is more and more nearly grazing, the total reflection moves ever nearer to the yellow region of the spectrum, at the same time the reflection in the orange and red increases and, for a certain angle, reaches a maximum. Further, the reflected red light must be polarised in the plane of incidence.

**228. Fringes by Reflection from Silvered Glass.** M. Hamy. (Soc. Franc. Phys., Bull. 8. pp. 185-204, 1906. Journ. de Physique, 5. pp. 789-809, Dec., 1906.)—A description and theory of the fringes formed when a pencil of light passes into a system composed of a plano-convex lens and a plane mirror, the plane surface of the lens being semi-silvered and set parallel to, and at a small distance from, the plane mirror. The light proceeds from a monochromatic source formed at the focus of the lens; a screen is placed in the path of the light with an aperture smaller than the pupil, and when the plane mirror is slightly inclined fringes are seen on placing the eye behind the opening in the screen. A second species of bands is produced by removing the diaphragm and making the reflecting surfaces rigorously parallel. The interfering beams which take part in the effect are of two kinds. The incident light gives rise to a beam which is reflected in the lens at the silver coating, and to a second beam which undergoes multiple partial reflections in air at the two silvered surfaces and which traverses the silver film on the lens twice. The theory of the fringes is then investigated, and it is found, among other things, that these are, in general, unsymmetrical. This is verified by experiment. In discussing the conditions of formation of the fringes it is pointed out that symmetrical fringes are also obtainable, the one condition necessary being that a parameter  $l$  should be a multiple of  $\lambda/2$ , where  $l$  is the retardation of a wave on traversing the silvering of the lens once in each direction, diminished by the retardations which occur at reflection from the two faces of the same silvering. This is a quantity which varies with wave-length, but experiment shows that the effect is extremely feeble. It is therefore argued that the variation of  $l$  is very small, and that this fact constitutes a curious property of silver as a refracting medium. Symmetrical fringes are obtained by silvering the lens until it has a reflecting power of 0.8. With a reflecting power of 0.5 the

fringes are still symmetrical and very brilliant, and lend themselves to the interferential analysis of sources of small intensity. An account of the application of the method to astronomical purposes is held over. G. E. A.

229. *Influence of Temperature on Absorption of Light in Isotropic Bodies.* R. A. Houstoun. (Ann. d. Physik, 21. 8. pp. 535-578, Nov. 20, 1906. From Dissertation, Göttingen.)—The effect of temperature on the absorption bands of coloured glasses and coloured solutions has been here investigated both by the spectroscope and the spectrophotometer. The paper gives the numbers obtained for seven glasses and seven solutions. It was found that our present experimental arrangements are not sensitive enough to detect the effect of pressure upon the absorption of coloured glasses. The author concludes from his observations that heating probably alters the number of electrons with proper vibrations per unit mass in the visible spectrum. He also finds that the simple dispersion theory is extended by consideration of the reciprocal forces of the electrons. The paper is illustrated by many curves and tables showing a good agreement between theory and experiment. [See also Abstracts Nos. 1484 (1901) and 888 (1902).] E. H. B.

230. *Asymmetrical Diffraction Bands due to a Rectangular Aperture.* C. V. Raman. (Phil. Mag. 12. pp. 494-498, Nov., 1906.)—When a pencil of monochromatic light coming from a slit in the focal plane of a collimating lens falls upon the object-glass of a telescope in front of which a narrow, rectangular aperture is placed with its sides parallel to the luminous slit of the collimator, the diffraction pattern seen in the focal plane of the telescope consists of a series of bright and dark bands symmetrically arranged on either side of the geometrical image of the slit, provided that the light falls normally upon the aperture. If, on the contrary, the aperture is held inclined to the incident pencil, its sides being still parallel to the slit, the diffraction pattern is not necessarily symmetrical. The symmetry is not, however, sensibly departed from unless the incidence be very oblique. The case in which this asymmetrical pattern was first seen is as follows: Place a prism on the table of a spectrometer and observe the image formed by the light reflected at very oblique incidence from one of the faces of the prism. With a prism of face-width 4.5 cm. and an incidence of  $85^\circ$ , the diffraction pattern seen in the field is sensibly symmetrical, and the minima of illumination equidistant from one another. If the incidence is greater than  $87^\circ$  this is no longer true. The bands are wider on one side of the pattern than on the other, those on the side towards the direct image of the slit being broader. This asymmetry increases greatly as the angle of incidence approaches  $90^\circ$ , and at the same time the number of bands on one side of the pattern, the side where they are broader, becomes smaller and smaller till at last they disappear altogether. A simple explanation of these facts then follows. E. H. B.

231. *Diffraction of Light at a Thin Cylindrical Wire.* W. Seitz. (Ann. d. Physik, 21. 5. pp. 1018-1029, Dec. 14, 1906.)—The rigorous mathematical treatment of the problem of diffraction of light has hitherto been accomplished only for a special case, and even here under definite limitations. Starting from the general differential equation for light obtained by Sommerfeld (and on a different method by Poincaré) the diffraction at a straight edge of an infinitely large plane screen has been obtained, first for plane waves of light, and second for light which has been con-

verged by a cylindrical lens. But the assumptions were made that the screen is infinitely thin and either absolutely reflecting or absolutely black. On the other hand, without limiting assumptions, the disturbances have been calculated which Hertzian waves suffer on encountering a sphere or an infinite cylindrical wire across their path (J. J. Thomson; W. Seitz; W. v. Ignatowsky) [see Abstracts Nos. 184 and 1294 (1906)]. The present paper extends these researches to the region of the visible spectrum, or at any rate to the red and infra-red rays. The treatment is highly analytical and unsuitable for detailed abstraction. The wire is taken both parallel and perpendicular to the electric force. Numerical calculations follow for infra-red light of  $\lambda = 1.5 \mu$  and a gold wire of radius  $0.716 \mu$ . The results are shown in five tables and three diagrams, having two curves each. In the case of the wire parallel to the electric force it is shown that there are maxima and minima of intensity, i.e., interference bands, both before and behind the wire.

E. H. B.

232. *Intensification of Glass Diffraction Gratings and the Diffraction Process of Colour Photography.* R. W. Wood. (Phil. Mag. 12. pp. 585-588, Dec., 1906.)—Following on a suggestion of Rayleigh's, the author has succeeded in intensifying glass diffraction gratings by immersing them for a short time in hydrofluoric acid. The back of the grating is protected by a coating of paraffin. The grating is enormously improved by this treatment; it has been found possible by starting with a fairly brilliant grating to produce a grating which almost completely suppressed the central image. Similar experiments upon speculum metal gratings failed entirely, probably owing to the crystalline nature of the speculum metal.

E. C. C. B.

233. *Demonstration of Abbe's Theory of the Microscope.* U. Behn and W. Heuse. (Phys. Zeitschr. 7. pp. 750-752; Discussion, pp. 752-758, Nov. 1, 1906. Paper read before the 78 Naturforscherversammlung, Stuttgart, Sept. 16-22, 1906.)—A modification of the method of A. Winkelmann [see Abstract No. 721 (1906)] for showing the experiment illustrating Abbe's theory of the microscope to an audience is described. Light from an arc is rendered parallel and falls upon a wire grating of 20 wires to the cm., a real image of which is produced by a lens  $L_1$ , and an enlarged image of this image is produced on the screen by means of a second lens  $L_2$ . Between  $L_1$  and the wire grating is placed a second grating of 60 lines to the cm. It is then found that the lines of the large image upon the screen are doubled, tripled, quadrupled, &c., according to the position of the fine grating relatively to the coarse grating and the lens  $L_1$ . The coarse grating should consist of wires of less diam. than half the grating constant, and the fine grating of wires of diam. greater than half the grating constant. S. G. S.

234. *A Consequence of the Principle of Interference.* A. Winkelmann. (Ann. d. Physik, 21. 2. pp. 270-280, Nov. 8, 1906.)—Referring to a passage in the collected essays of E. Abbe (Vol. 2, p. 248), in which there is contained the development of an interesting consequence of the interference principle which Abbe notes is susceptible of experimental proof, the author here gives this proof of the theoretical result and also deduces the result from the phenomena of diffraction. Abbe's result is as follows: If the rays from two sources of light A and B interfere and the wave-length of the light made use of be denoted by  $\lambda$ , there is obtained when the angle between the



directions of the rays is  $\omega$  bands of the width  $b$ , where  $b$  is given by the equation  $b = \lambda/[2 \sin(\omega/2)]$ . In the interference space there is formed a wave system with an apparent wave-length  $\lambda'$  greater than  $\lambda$ . In fact—

$$\lambda'/\lambda = 1/\cos(\omega/2).$$

Hence it follows, to a first approximation, that  $\lambda'/\lambda = 1 + (\lambda/b)^2/8$ . A geometrical proof is given of this result, and the consequences are discussed in connection with the theory of diffraction. J. J. S.

**235. Influence of Electric Charge on Acetylene Flame.** C. F. Lorenz. (Phys. Zeitschr. 8, pp. 20-23, Jan. 1, 1907. State Univ. of Iowa, Iowa City, Sept., 1906. Translation. Écl. Electr. 50, pp. 202-208, Feb. 9, 1907.)—This paper describes researches on the effect of an electric charge on the brightness and length of a cylindrical acetylene flame. Photographs are given of flames uncharged, and also when subject to an alternating current of period 60 and strength 0.01 amp. In the latter case the flame is much shorter and also about five times as bright as without the charge. Plotting the c.p. of the flame with the current strength, a curve is obtained which shows that the c.p. increases uniformly from the value 7.5 with no current to the value 37.5 with a current strength of 40 milliamps., above which value increase of current produces no increase in brightness. Photographs obtained by means of a revolving mirror are also given, which show that the height of the flame varies with the alternations of the current. [See also Abstract No. 2079 (1902.)] A. W.

**236. Magneto-Optical Phenomenon of a Crystal theoretically explained.** J. Becquerel. (Comptes Rendus, 143, pp. 890-892, Dec. 8, 1906.)—The author has recently (Ibid. pp. 769-772, Nov. 19) established on the electron theory an expression for the coefficient of absorption of a crystal to a pencil of light along one direction when there is a magnetic field in a direction at right angles. The paper then includes curves based upon this and showing the various symmetrical and asymmetrical doublets that may be obtained and how they change with increasing fields. (Ibid. pp. 962-964, Dec. 10, 1906.)—Following the previous treatment, the case of magnetic field and propagation of light along the same line is here mathematically treated. According to this theory and the result of experiments on *xenotime* it is inferred that positive and negative electrons are simultaneously present, for which  $e/m$  can reach  $1.1 \times 10^6$ , a value 6-10 times greater than that corresponding to the cathodic corpuscles. (Ibid. 144, p. 167, Jan. 21, 1907.)—*Errata*. [In the papers dealt with in Abstracts Nos. 886 and 1056 (1906) the values given for the magnetic field employed should be multiplied by 4/5.] E. H. B.

**237. Infra-red Dispersion of Magnetic Rotation.** L. R. Ingersoll. (Phys. Rev. 23, pp. 489-497, Dec., 1906.)—An improved method of measurement is described and results of application to water are given. The method is similar to that described in Abstract No. 515 (1906), but an arrangement by which two beams of light from the same source fall upon two strips of a bolometer is used. The plane of polarisation of the radiation as it passes between the poles of the magnet makes an angle of  $45^\circ$  with each of the two planes of transmission of the analysing double-image prism, and thus any rotation will cause a diminution of intensity of one image on the slit and a corresponding increase in the other. Details are given for the rotatory dispersion of water in a field of about 13,000 c.g.s. units over a spectrum range  $\lambda = 0.7 \mu$  to  $\lambda = 1.8 \mu$ . J. W. P.

**238. Distribution of Light in Dispersion Bands.** **W. H. Julius.** (Konink. Akad. Wetensch. Amsterdam, Versl. 15. pp. 817-888, Nov. 7, 1906. Proc., 9. pp. 848-869, Nov. 22, 1906.)—Various phenomena connected with dispersion bands produced by anomalous dispersion are described, in continuation of former papers [Abstracts Nos. 65, 1892 (1905)]. New apparatus has been made so that the density of the absorbing vapour could be kept more nearly constant. Sodium metal was introduced into a nickel tube partly enclosed in an electric furnace, with control devices for accurately regulating the amount of substance vaporised. Excellent reproductions of photographs obtained under various conditions are given, and the probable application of these phenomena to the explanation of the solar prominences, &c., is discussed.

C. P. B.

**239. A Kinematical Explanation of Groups of Spectrum Lines with Constant Frequency-difference.** **G. A. Schott.** (Phil. Mag. 12. pp. 579-580, Dec., 1906.)—In reference to Wood's observation [see Abstract No. 248 (1907)] of five or more groups of nearly equidistant lines in the fluorescence and magnetic rotation spectra of sodium, the author points out that if two coaxial rings of electrons be considered, each with uniform angular velocity, the vibrations emitted in consequence of the interaction of the two rings will form groups of constant frequency-difference. This is applicable not only to Wood's observations, but also to the groups of constant frequency-difference in the spectra of Sn, Pb, As, Sb, Bi. The author suggests that the variations from perfect constancy in the frequency-differences as observed by Wood are due to the near approach of sodium atoms other than those to which the vibrating rings belong.

E. C. C. B.

**240. A New Empirical Spectral Formula.** **E. E. Mogendorff.** (Konink. Akad. Wetensch. Amsterdam, Versl. 15. pp. 429-438, Dec. 5, 1906. Proc., 9. pp. 434-443, Dec. 21, 1906.)—It is pointed out that the value of the constant  $N_0$  in Rydberg's formula  $n = A - N_0/(m + a)^2$  varies beyond justifiable limits and it is proposed to substitute the formula  $n = A - N_0/(m + a + b/m)^2$  and use Rydberg's value,  $N_0 = 109675$ . The results of applying this formula are given, and it is shown how values are obtained which are considerably better than those of Kayser and Runge.

E. C. C. B.

**241. Spectroscopic Study of the Spark Spectrum.** **W. B. Anderson.** (Astrophys. Journ. 24. pp. 221-254, Nov., 1906.)—An investigation of the effect of pressure, self-induction, capacity, energy, resistance, and voltage upon the spark spectrum. The pressure was varied within the range of 1 to 100 atmos., the self-induction was varied within 0.0185 and 140 millihenrys, the capacity within 0.00145 and 0.2231 mfd., the energy within 4 and 125 watts; the resistance used in addition to that of the spark was varied within a range of 0.2 to 78 ohms, while the voltage of the spark was varied between about 2,000 and 12,000 volts. The author finds that the effect of pressure is to cause the bright lines to increase in width and then to reverse and to appear as black lines upon a continuous spectrum. With small capacity and large self-induction a greater pressure is required to widen the lines; this may tend to modify conclusions drawn from previous work when these two factors were not stated. Capacity has very much the same effect as pressure. Similar observations are recorded of the triplets at  $\lambda\lambda = 8710$  and  $8765$  to those by Hale. Self-induction has the opposite effect to that of capacity or pressure; the effect of increasing the external resistance is the same as that

of increasing the self-induction. The effect of increasing the energy in the spark from 27 to 120 watts is similar to that produced by increase of capacity, the absorption lines becoming about one-third wider and the continuous spectrum more intense. The increase of potential produced by lengthening the spark-gap makes the lines become somewhat narrower. When  $\text{CO}_2$  is used in the compression chamber wider lines are obtained than with air, but narrower than with  $\text{H}_2$ . The pressure-shifts for thirty different lines were determined and found to be the same as observed by Humphreys and Mohler for the arc. The shifts have been determined for pressures up to 100 atmos. in  $\text{CO}_2$  and  $\text{H}_2$ , and are less in the latter gas. Full details and discussion appear together with reproductions of the spectra. E. C. C. B.

242. *Formation and Spectrum of Metallic Vapour in the Spark.* B. Walter. (Ann. d. Physik, 21. 2. pp. 228-238, Nov. 8, 1906. Physikal. Staatslaborat., Hamburg, July, 1906. Ecl. Electr. 50. pp. 28-24, Jan. 5, 1907.)—J. de Kowalski and P. B. Huber have shown [see Abstract No. 1057 (1906)] that in the case of the spark spectrum of alloys of Cu with Zn and with Mg the introduction of self-induction into the circuit causes the disappearance of a smaller number of lines than in the case of the pure metals; further, they showed that the Cu lines disappeared last in the case of each alloy. The author has repeated these experiments with brass electrodes, and confirms the second observation, but not the first. He has also found that the relative intensity of the Cu lines is greater with brass electrodes than the composition of the alloy accounts for; this is attributed to the fact that the electrical evaporation of Cu (under reduced pressure) is greater than that of Zn. On the other hand, at high temperatures the electrical evaporation of Zn is the greater. It follows therefore that with the ordinary spark between brass electrodes the relative electrical evaporation of the Zn is high and the Zn lines are strong, but as the spark is cooled by the introduction of self-induction into the circuit the electrical evaporation of Zn falls below that of Cu, and therefore the Zn lines begin to disappear before the Cu lines.

E. C. C. B.

243. *The Spectra of Hydrogen.* A. Dufour. (Annal. Chim. Phys. 9. pp. 361-432, Nov., 1906.)—In this interesting paper are described experiments undertaken with the view of explaining the origin of the two spectra of hydrogen—the bright-line spectrum which obeys Balmer's law and the so-called secondary spectrum which is generally seen along with the first when hydrogen is illuminated by the electric discharge. The views of previous experimenters are dealt with at length, being on the one side that the second spectrum is due to an impurity, and on the other that it is due to hydrogen itself. In the first part the author describes experiments upon hydrogen under reduced pressure, and shows that the spectrum cannot be due to an impurity, as no difference whatever in the relative intensity of the two spectra could be obtained by the use of the most elaborate and rigid precautions against the introduction of an impurity. Further, altering the method of preparation did not alter the secondary spectrum, a very important result, as it is in the highest degree improbable that a definite and constant impurity should be common to all the methods of preparation. Experiments are next described upon the discharge through hydrogen under pressures greater than 5 cm. The spectra seen are generally the same as those under very reduced pressure, and are quite independent of the nature of the electrodes employed. Experiments are also described proving that the

secondary spectrum is not due to any occluded gas either in the electrodes or the walls of the vessel. Cornu's experiments are confirmed, namely, that the discharge passed through pure water vapour shows no trace of the secondary spectrum. When a condenser is intercalated in the circuit the secondary spectrum disappears, and the first spectrum appears upon a black background. Finally, the spectrum of the brush discharge through hydrogen shows only the secondary spectrum. The author has also examined the influence of a magnetic field upon the secondary spectrum and finds that although a few lines are affected, by far the greater number are uninfluenced. For these reasons the author concludes that the bright-line or primary spectrum is due to atomic or dissociated hydrogen, while the secondary spectrum is due to molecular hydrogen. This theory explains very satisfactorily all the results described in the paper. The author applies Richardson's dissociation equations with considerable success. E. C. C. B.

**244. The Self-reversal of the Hydrogen Lines.** R. W. Wood. (Phys. Zeitschr. 7, pp. 926-927, Dec. 15, 1906. From the English.)—When the condensed spark discharge through rarefied hydrogen in a vacuum tube with a long capillary portion is viewed "end-on," the colour of the discharge appears blue, while the colour of short lengths appears red. The author shows that this effect is due to the strong absorption of the red rays by the luminescent gas. A vacuum tube was constructed with a very long and a very short capillary portion arranged side by side and in series. The colour of the discharge in the short capillary was red, while that in the long tube had no red tinge, both capillaries being viewed "end-on"; this was also the case when the intensity of the light from the long capillary was reduced by partially crossed nicols. E. C. C. B.

**245. The "Swan" Spectrum.** W. M. Watts and H. M. Wilkinson. (Phil. Mag. 12, pp. 581-585, Dec., 1906.)—The authors have observed the spectrum of the spark when made to pass at atmospheric pressure in certain liquid compounds of carbon which contain no oxygen; chloroform, benzene-naphthalene, aniline, ethylene-dibromide, and ethyl bromide were used in as great a degree as possible, and though much carbon was deposited it was possible to observe that the Swan spectrum is produced in each case. The same is true in the case of methyl and ethyl alcohols and acetic acid, which all contain hydrogen. These results do not support Smithell's view that this spectrum is due to CO. E. C. C. B.

**246. Spectra of Salts of the Rare Earths in Different Solvents.** H. Schaeffer. (Phys. Zeitschr. 7, pp. 822-831, Nov. 8, 1906.)—The salts of the rare earths are distinguished from the organic dyes by the narrowness and sharp definition of the spectrum absorption lines and by the uniform distribution of the lines over the whole spectrum; they are specially suitable, therefore, for testing the validity of Kundt's rule. The experiments described in the present paper show that solutions of the nitrates of Di, Cu, and Nd in methyl alcohol, in ethyl alcohol, in propyl alcohol, in butyl alcohol, in amyl alcohol, in allyl alcohol, in glycerine or in benzyl alcohol, do not obey Kundt's rule; the refractive and dispersive indices have very little connection with the displacement of the absorption lines. Generally speaking, it was found that the displacements were greatest for the solvents with the smallest refractive indices. The displacements in the yellow and green regions of the spectrum

were usually greater than in the blue and violet. In opposition to Living [Abstract No. 860 (1899) and Trans. Camb. Phil. Soc. 18. pp. 208-218, 1899], the author finds that there is displacement of the spectral lines when an aqueous solution of didymium nitrate is diluted. In 1865 Melde pointed out that in certain cases the spectrum of a mixture of two solutions was different from the spectrum obtained when the two solutions were placed one behind the other and then spectroscopically examined; the present author finds that the Melde-effect is not exhibited in the case of nitrates of didymium and cerium, didymium and erbium, neodymium and cerium, cerium and erbium, neodymium and erbium. D. H. J.

247. *The Zeeman Phenomenon.* W. Lohmann. (Phys. Zeitschr. 7. pp. 809-811, Nov. 8, 1906. Phys. Inst., Halle, Oct., 1906.)—Some observations upon the resolution of a few mercury and helium lines and the neon lines in the magnetic field. The mercury line at  $\lambda = 5789$  gives in weak fields a normal triplet, which is resolved into a nonet in stronger fields. This nonet is found to possess an abnormal distribution of intensity because the strongest of the components vibrating perpendicular to the lines of force appear at the outside of the system. This also appears in the neon spectrum. The types of resolution in the neon spectrum are very numerous, and but little regularity is to be observed. There are only two pairs with equal frequency-difference, and there is no fundamental interval, as appears in the mercury spectrum. The observed types are derived from the normal triplet by its resolution into 2, 3, 4, or 5 components. Three of the nonets show normal intensity distribution, and four of them the abnormal, as described above for the Hg  $\lambda = 5789$ . E. C. C. B.

248. *Fluorescence and Magnetic Rotation Spectra of Sodium Vapour and their Analysis.* R. W. Wood. (Phil. Mag. 12. pp. 499-524, Nov., 1906. Paper read before the Physical Soc., Oct. 26, 1906. Amer. Acad., Proc. 42. No. 13. pp. 235-260, Nov., 1906. Phys. Zeitschr. 7. pp. 878-892, Dec. 1, 1906.)—A continuation of the author's investigation into these spectra [see Abstracts Nos. 2878 (1904) and 2177 (1905)]. The absorption spectrum has been investigated by means of the 12-ft. concave grating between  $\lambda = 4800$  and  $\lambda = 5700$ , and contains about 1,500 lines. Only a few of these lines have any connection with the fluorescence and magnetic rotation spectra, and it is noteworthy that these particular lines are profoundly modified by the presence of inert gases. The magnetic rotation spectrum was examined both with the grating and a 3-prism spectrograph. It contains about 60 lines of variable intensity. The fluorescence spectrum has been completely examined when excited, both with white light and with certain specified radiations. In the former case the spectrum is very complex, inasmuch as it is a superposition of a number of simpler spectra, any one of which can be independently excited by controlling the wave-length of the stimulating light. Each of the simpler fluorescent spectra is made up of widely separated bright lines, placed in many instances at nearly equal wave-length intervals apart. In the case of stimulation by certain specified radiations it was found that the Cd line  $\lambda = 480$  gave rise to a fluorescence spectrum, consisting of a series of lines with an average wave-length difference of 38. Certain lines were missing from the series, but the series was found to be complete when the Ag radiation  $\lambda = 5207$  was used as the exciter. The green Cd line ( $\lambda = 5086$ ) gave a series of eleven pairs of lines regularly spaced. The magnetic rotation spectrum contains a series of lines analogous to the fluorescence



series produced by the Cd 480 line; it also contains a series coinciding with the series formed by the shorter wave-length lines of the pairs in the Cd 5086 spectrum. In the case of stimulation by the lines of Zn there is undoubted evidence of series, but the lines are very complicated. The Bi line at 4724 gave an entirely different spectrum from the Zn line at 4722. The Pb line at 5001 excited a series which coincided exactly with a series in the magnetic rotation spectrum, the He line 5015 gave a series of lines which fall exactly midway between the lines of the second and third magnetic series. The He line 4718 gives a series which is the same as that given by Zn 468; this is due to the fact that the line 4718 coincides with one line in the series given by Zn 468. Li 4601 (the shortest monochromatic stimulator found up to the present) gives a series in the violet and a number of lines in the yellow green. Li 4971 gives a series coinciding with the second magnetic series. As pointed out in a previous paper, Na 5898 gives a resonance radiation. Kathode rays act like white light. A curious phenomenon was sometimes observed in this case; on looking obliquely into the tube the point of entry of the kathode rays into the Na vapour was marked by a spot of green fluorescent light, while the point of exit was marked by a spot of yellow light, the intermediate space being non-luminous. Thus the complex (white light excitation) fluorescence spectrum is made up of six or more series, each of which has a wave-length difference of about 88 A.U. (the spacing tends to decrease towards the violet). As in several cases these series coincide with those in the magnetic rotation spectra, the author has been able to construct five series in the latter, also with a wave-length difference of 88. Photographs of the spectra and a complete chart are given with the paper.

E. C. C. B.

249. *Fluorescence, Luminescence, and Chemical Constitution.* C. S. S. Webster. (Chem. News, 94. p. 298, Dec. 21, 1906.)—The groups  $-\text{NH}_2$ ,  $-\text{OH}$ , and  $-\text{COOH}$ , which increase the fluorescence of aromatic compounds, also increase the luminosity produced by the action of radium salts. Similarly the radicals  $-\text{NO}_2$ ,  $-\text{Cl}$ ,  $-\text{Br}$ ,  $\text{C}_6\text{H}_5$ ,  $\text{CO}-$ , and  $\text{CH}_3$ ,  $\text{CO}-$ , diminish the intensity of both effects. It is proposed to make use of these facts to check the chemical constitution of new substances of which only minute quantities are available.

T. M. L.

250. *Action of Resin on Photographic Plates.* P. Carnazzi. (N. Cimento, 12. pp. 187-141, Sept., 1906.)—Investigates the cause of the action of wood and resin described by W. J. Russell [see Abstract No. 2219 (1906)]. Electrometric and photographic experiments were made which excluded rectilinear propagation, and others in the dark, in a vacuum, and in various gases. It appears that the activity of resin is not due to a radiation proceeding from it, nor induced by it, nor induced by light, but to a gaseous product of decomposition of the resin, which diffuses out through space, and is capable of gradually bending round an obstacle.

E. E. F.

251. *Variations in Radio-active Transformations.* K. W. F. Kohlrausch. (Akad. Wiss. Wien, Sitz. Ber. 115. 2a. pp. 678-682, May, 1906. From the II. phys. Inst. d. Univ., Wien.)—Discusses the dependence of the rate of disintegration upon the number of atoms present. The larger this number the more constant will be the proportion of atoms undergoing disintegration in unit time. According to v. Schweidler, the mean variation

only depends upon the number  $Z$  of atoms which, in case the law represented by  $n = Ne^{-\lambda t}$  is accurately fulfilled, would disintegrate in a time  $\delta$ , and is proportional to  $1/\sqrt{Z}$ . This relation is experimentally confirmed by the author. E. E. F.

252. *Absorption of  $\alpha$ -Rays in Gases and Vapours.* E. P. Adams. (Phys. Rev. 24. pp. 108-114, Jan., 1907.)—The source of  $\alpha$ -rays was polonium extracted from carnotite, and the method of extraction is described. The polonium, deposited on a plate of bismuth, is set at a distance from a zinc sulphide screen, both being enclosed in a tube which holds the gas under examination. For each gas is measured the pressure  $p$  and the maximum distance  $d$  between the active plate and the zinc sulphide screen at which scintillations could be seen through a magnifying glass. The product of these two quantities is found to be constant for any one gas or vapour. Further, the product  $pd\Sigma\sqrt{A}$  is very nearly constant for a range of eighteen substances, where  $\Sigma\sqrt{A}$  is the sum of the square roots of the atomic weights of the atoms in the molecule, and has the average value of about 2,000 for these substances, viz., hydrogen, helium, argon, methane, air, &c. G. E. A.

253. *Velocity and Energy of the  $\alpha$ -Particles from Radio-active Substances.* E. Rutherford. (Phil. Mag. 18. pp. 110-117, Jan., 1907.)—The paper contains no new experimental results; but a large amount of data respecting the  $\alpha$ -rays is tabulated and discussed. Thus Table I. gives the various active substances known with their period of transformation, the range and velocity of the  $\alpha$ -particles, and their kinetic energy. Table II. gives the average velocity of the  $\alpha$ -particles for each family of elements, the average energy of the  $\alpha$ -particles in ergs, and the total energy liberated as the result of the successive disintegration of one atom of parent matter. This brings out the following points: Of all products the  $\alpha$ -particles from ThC have the greatest, those from Ur and Ra the least velocity. The average velocity and energy of the  $\alpha$ -particles from Th and Ac families are nearly the same, and are greater than the corresponding values for radium. The total energy liberated by the successive disintegrations of a Ra atom is less than that for a Th atom but greater than for an atom of Ac. Table III. shows that the velocity of expulsion of the  $\alpha$ -particle progressively increases with the decrease of period of transformation. The exceptions to this rule are RaC, ThX, and AcX. If the rule held for all products, the period of RaC should be less than 1 min., while ThX and AcX should be transformed in a few seconds; in each case there being two changes, probably a rapid change giving rays and another, which is rayless, having the period usually accepted for these products. No simple connection has been found between the velocity of expulsion of the  $\alpha$ -particle and the period of transformation. Hahn has pointed out that the corresponding products of thorium and actinium occupy the same relative position when the products of each element are arranged in order of increasing velocity of the  $\alpha$ -particles expelled from them. R. S. W.

254. *The  $\alpha$ -Rays.* O. W. Richardson. (Nature, 75. pp. 223-224, Jan. 3, 1907.)—The  $\alpha$ -rays from radium appear to originate without electric charge, and to become charged subsequently owing to collisions with gas molecules in their path. The question arises, What would be their behaviour if they were liable to loss of charge at a later collision? The  $\alpha$ -particle may be capable of losing more than one electron, and may have a greater charge at

some portions of its path than at others. Suppose for a distance  $x$  of its path it possesses an electric charge  $e$ , and then for a distance  $x'$  a charge  $e'$ , then again for a distance  $x$  a charge  $e$ , next a distance  $x'$  with charge  $e'$ , and so on indefinitely. If the particle have a mass  $m$  and initial velocity  $v_0$ , considering a portion of the path so small that  $v_0$  is not appreciably diminished by collisions, it may be shown that the quantity measured by the electrostatic deflection as  $mv_0^2/e$  would really be  $mv_0^2(x+x')/(ex+e'x')$ , whilst the quantity measured by the electromagnetic deflection as  $mv_0/e$  would be—

$$mv_0(x+x')/(ex+e'x').$$

Thus the measurements would give  $v_0$  correctly, but the quantity denoted by  $e/m$  would be  $(ex+e'x')/m(x+x')$ . Supposing the particle *uncharged* during one series of portions of its path, and having the ordinary electrolytic unit of charge  $e$  during the alternating portions (if the alternate stretches were equal, this is what would be obtained if it were an even chance whether the  $\alpha$ -particle escaped with or without a charge after each encounter), then  $x=x'$  and  $e'=0$ , and the measured value of  $e/m$  would really be  $e/2m$ . On this view Rutherford's measurements would indicate that the  $\alpha$ -particles are hydrogen atoms with the normal charge instead of helium atoms with twice that charge. If the  $\alpha$ -particle turns out to be a helium atom it is possible that its charge might vary periodically somewhat in the manner indicated. Then the average charge would be twice the electrolytic unit. By this view an explanation would be afforded of the cessation of ionising and other effects by the  $\alpha$ -particle at a stage when it possesses a much greater amount of energy than that which is known to be required by a positive ion to produce other ions by collision.

255. *Radium and Helium.* **B. Walter.** (Nature, 75, p. 102, Nov. 29, 1906.)—Referring to the hypothesis that radio-active phenomena are associated with atomic degradation, and that the loss of an atom of helium (atomic weight 4) frequently accompanies such changes, it is observed that the transformation of the uranium atom (238.5) into radium (226) occurs owing to the loss of *three* helium atoms, whilst the change of radium into lead (206.5) is due to the loss of *five* such atoms. The discrepancy in the numbers,  $238.5 - 3 \times 4 = 226.5$  instead of 225, and  $226.5 - 5 \times 4 = 206.5$  instead of 206, can be satisfactorily accounted for if it is assumed that the atomic weight of radium is not 225 but 226.5, for then  $238.5 - 3 \times 4 = 226.5$  and  $226.5 - 5 \times 4 = 206.5$ . This assumption of a slightly higher atomic weight for radium than that found by Mme. Curie does not appear unwarranted, as the values given for the atomic weight of radium have become greater and greater as the material used in the determination has been obtained increasingly purer. **H. S. Allen.** (Ibid. p. 128, Dec. 6, 1906.)—Allen suggests that certain difficulties in the way of the acceptance of Rutherford's degradation hypothesis may be removed by adopting another suggestion of Rutherford, viz., that the  $\alpha$ -particle is *one-half* of the helium atom carrying a single ionic charge. Then two series of successive derivatives of uranium would be possible. **B. B. Boltwood.** (Ibid. 75, p. 223, Jan. 8, 1907.)—Boltwood brings forward objections to the view of Allen that the difficulty encountered in introducing actinium with its four  $\alpha$ -ray products between uranium and radium can be removed by assuming that the  $\alpha$ -particle is one-half of the helium atom. (1) The first of these objections is that the continuation of the same line of reasoning would lead to the assumption of

no less than seven  $\alpha$ -ray changes between radium and its final disintegration product, lead, while but four are known. (2) The activity of the actinium in equilibrium with radium in minerals is too low to permit any such conclusion. Boltwood considers that the hypothesis that lead is the final disintegration product of uranium is proved to be correct by the fact that in unaltered primary minerals from the same locality the amount of lead is proportional to the amount of uranium in the mineral, and that in unaltered primary minerals from different localities the amount of lead relative to uranium is greatest in the minerals from the locality which on the basis of geological data is the oldest. From observations on the values of the activity of the various products of uranium and of actinium Rutherford and Boltwood concluded that actinium is not a direct product of uranium in the same sense as is radium. The following interesting suggestion is made: If the two changes in uranium and the five changes in radium are each assumed to take place with the expulsion of four  $\alpha$ -particles, and the four changes in actinium with the expulsion of only one  $\alpha$ -particle each, the conditions required by the relative activities of the various substances would appear to be fulfilled, and if, moreover, the mass of each  $\alpha$ -particle be taken as 1, then the indicated atomic weights of the successive elements are in fairly good agreement with the accepted values. Then  $Ur = 238.5$ ,  $Ac = 230.5$ ,  $Ra = 226.5$ , and  $RaF$  (lead)  $= 206.5$ . This would involve revision of the accepted value of  $e/m$  for the  $\alpha$ -particle. J. J. S.

**256. Radio-actinium. O. Hahn.** (Phil. Mag. 13. pp. 165-180, Jan., 1907. Phys. Zeitschr. 7. pp. 855-864, Nov. 15, 1906. Écl. Électr. 50. pp. 24-25, Jan. 5, 1907.)—This is an extended study of the substance whose discovery by the present author was announced in May of last year [Abstract No. 1066 (1906)]. Two methods of separation from Ac and AcX are given. In the first, Ac is precipitated several times with ammonia, AcX remains in solution, and Ac and radio-actinium are contained in the precipitate. The latter is dissolved in HCl, and to the acid solution a little sodium thiosulphate is added. The amorphous sulphur which appears is allowed to settle, and carries down with it the radio-actinium. The second method has already been given in a previous paper [Abstract No. 2088 (1906)]. The substance emits  $\alpha$ -rays; the small  $\beta$ -ray activity is probably due to AcB. The period of half transformation is found 19.5 days instead of the 20 days given earlier. It is clearly shown by the experiments that RaAct. [the author's abbreviation] gives rise to AcX. The curve showing the  $\alpha$ -ray activity of RaAct., in which all the successive products are supposed to remain, is deduced, the ionising power of each product being taken proportional to the range of the  $\alpha$ -particle it emits. Good agreement with experiment is found. As regards the rise of the  $\beta$ -ray activity, theory and experiment are in excellent agreement also. It is shown that the  $\alpha$ -ray activity of Ac can be reduced to 2.5 per cent. of its initial value by separating from it RaAct. as far as possible. The curve of recovery of this inactive product agrees well with that deduced from theory if RaAct. is taken as the product intermediate between Ac and AcX, but not at all if it is supposed that Ac is the immediate source of AcX. Radio-actinium is not volatilised at a temperature where AcA and AcB are freely volatile. R. S. W.

**257. Production of Radium from Actinium. E. Rutherford.** (Nature, 75. pp. 270-271, Jan. 17, 1907.)—In the Bakerian lecture for 1904 the author gave a brief account of experiments he had commenced to see whether

actinium produced radium. From a solution of actinium in acid the greater part of the radium was removed by precipitating barium in the solution. The radium remaining was determined by the emanation method and comparison with a standard solution of radium. No certain evidence was obtained over a period of 8 months that the amount of radium had increased. For various reasons the solution was not further tested for 2½ years, but since Boltwood's experiments appeared [Abstract No. 68 (1907)], further measurements have been made on it. Preliminary measurements showed a large growth of radium, but unfortunately the solution was contaminated with radium while these were in progress. The original salt from which the solution had been prepared was available and its radium content had, at that time, been determined. Experiments with this now show an increase of at least four times the initial amount of radium in 2½ years. The earlier failure to observe these effects is ascribed to the unsuitable chemical treatment used to separate the radium from the actinium, giving rise to an excess of  $H_2SO_4$  in solution, which would precipitate the radium as sulphate. In this condition only a small portion of the emanation would be removed by drawing air through the solution. The contaminated solution has now been successfully freed from radium, except for a minute quantity, and the growth of this substance observed over a period of five weeks. This growth amounts to 80 per cent. of the initial value. At this rate the amount of radium in solution should be eight times its initial value at the end of one year. This production of radium might arise, not from the actinium itself, but from another substance normally separated from the radio-active mineral with the actinium. A comparison of the actual rate of growth with that to be expected on the simple theory that actinium is transformed directly into radium shows that the two agree if the period of half transformation of radium is about 2,600 years. Such an agreement, however, implies that the activity due to actinium in pitchblende is about equal to that of radium and its products, and this is not the case, as Boltwood has shown. Further experiments are therefore required. If radium arises from actinium, it should be produced by  $AcA$  and  $AcB$ . An active deposit from actinium is produced on a platinum plate, and the rate of growth of radium is found not more than  $1/5$  of the theoretical amount. This may be due to the presence of another change between  $AcB$  and radium, or, what is more probable, to the loss in an electric field of the radium formed on the plate. There is no doubt that the immediate parent of radium is present in actinium from pitchblende, but it is not definitely proved that radium is the direct lineal descendant of actinium.

R. S. W.

258. *Relative Activity of Radium and Thorium.* A. S. Eve. (Amer. Journ. Sci. 22, pp. 477-480, Dec., 1906.)—The author determines the ratio of the  $\gamma$ -activities of radium and thorium when both are in radio-active equilibrium. He also ascertains the relative amounts of radio-thorium in thorianite and thorium nitrate respectively by measurement of the  $\gamma$ -radiations. He finds that radium bromide is 4.5 million times as active as  $ThO_2$ , or that radium is 6.9 million times as active as thorium, measured by the  $\gamma$ -rays, when both are in radio-active equilibrium. The ratio of the quantity of radio-thorium per gm. of thorium present in thorianite and in thorium nitrate has been measured by Boltwood, using the  $\alpha$ -ray method [Abstract No. 1387 (1906)]; and by Dadourian, using the emanation method [Abstract No. 1888 (1906)]. The results so obtained are in good agreement with the author's results obtained by the  $\gamma$ -ray method.

E. E. F.



259. *Effect of Radium on the Strength of Threads.* J. L. McKee and W. B. Morton. (Nature, 75. p. 224, Jan. 3, 1907.)—A continuation of the experiments described in Abstract No. 1898 (1905), using cotton threads. No difference in the effect is found when the emanation, oxygen, and moisture are removed. When threads or filter-paper are dyed with methylene blue, after exposure to radium the exposed part is a deeper colour than the rest. This is given as a test for the presence of oxycellulose. When the weakening produced is plotted against distance, a sharp bend is shown at 9 mm., suggesting the end of the effective range of the  $\alpha$ -rays, similar to Bragg's experiments. R. S. W.

260. *Radio-activity of the Waters of Spa.* E. Gerard and F. Fontaine. (Assoc. Ing. Éli. Liège, Bull. 6. pp. 241-252, June-July, 1906.)—A description of the dispersion apparatus with the method of finding the capacity of the electroscope and discharge cylinder is given. The saturation current can then be found in terms of the capacity and rate of fall of potential. The water is stored in closed bottles, which are completely filled so that no air-space into which the emanation can diffuse remains. It is then shaken up with an equal volume of air and the dispersion observations immediately afterwards begun. Water from 22 sources is examined, the greatest saturation current being  $8.88 \times 10^{-8}$  electrostatic unit. S. G. S.

261. *Radio-activity of the Deposits from the Thermal Springs of Bagni di Lucca, Tuscany.* G. Magri. (Accad. Lincei, Atti, 15. pp. 699-704, Dec. 2, 1906.)—The deposit is treated with aqua regia and the metals separated in groups from the solution by the ordinary methods of chemical analysis, and the precipitates are dried and the radio-activity of equal masses of them determined. In volts per hour the radio-activities of the various parts are as follows: Original deposit, 388.4; residue of silica unattacked by aqua regia, 28.7; Ba, Ca, and Sr residues, 6.5; group II., arsenic and traces of lead, 948.1; Fe, Al, and Mn group, 840; the remaining groups either small radio-activity or none at all. The emanation from the solution is then examined, and from its behaviour the presence of radium and thorium is deduced. On account of the feeble activity of the emanation, it is undecided whether actinium is present or not. [Also see Abstract No. 727 (1906).]

S. G. S.

262. *Malacene, a Silicate of Zirconium, containing Argon and Helium.* E. S. Kitchin and W. G. Winterson. (Chem. Soc., Journ. 89. pp. 1568-1575, Nov., 1906.)—This mineral, first described by Scherer in 1844, is radio-active, and when heated gave off, in c.c.m. per 100 gm. of material, 38.24  $\text{CO}_2$ , 0.57 hydrogen, 0.84 nitrogen, 0.94 helium, 2.82 argon. The liberation of argon is the most remarkable property of the mineral, as this does not occur in the case of other radio-active materials. Although it consists chiefly of zirconium silicate, the mineral contains a little uranium (0.33 per cent.), and this would account for about one-fifth of the radio-activity, and possibly for the helium, as this is normally present in uranium minerals. No explanation is given of the origin of the argon. T. M. L.

263. *Thorianite and the Relative Radio-activity of its Constituents.* E. H. Büchner. (Roy. Soc., Proc. Ser. A. 78. pp. 885-891, Dec. 20, 1906. Chem. News, 94. pp. 233-235, Nov. 16, 1906.)—The chief constituents of this mineral

are thorium and uranium, but it also contains small quantities of Ce, La, Fe, Pb, Ca, Zr, He, and didymium. Its radio-activity is 88.8 per cent. of that of standard uranium oxide, and this property is associated almost entirely with the soluble part of the mineral. Tables of the analysis and of the comparative radio-activity of the constituents are given. G. E. A.

264. *Helium and Argon in Common Rocks.* R. J. Strutt. (Nature, 75. p. 271, Jan. 17, 1907.)—The quantity of radium found in granites and kindred rocks, about  $10^{-11}$  gm. per c.cm., suggested that the associated helium might be present in sufficient quantity for spectroscopic detection. This is proved to be the case. By heating 250 gm. of granite 8 c.cm. of nitrogen are obtained, which, on sparking down, leaves a residue of about 1/100th part of its own volume. When this is introduced into a vacuum tube it shows the spectra of argon and helium in about equal intensity, and quite brilliantly. This observation explains the presence of helium in mineral springs. The author intends to test a selection of common rocks to determine whether helium is always associated with radium, or whether its presence can ever be attributed to radio-activity of ordinary materials. R. S. W.

# REFERENCES.

265. *Metallic Reflection.* R. Sissingh. (Archives Néerlandaises, 11. pp. 206-223, 1906.)—The full paper corresponding to Abstract No. 533 (1906).

266. *Absorption Bands of a Crystal in a Magnetic Field.* J. Becquerel. (Comptes Rendus, 143. pp. 1133-1136, Dec. 24, 1906.)—This paper contains further remarks upon the subject of a previous article [see Abstracts Nos. 1056 (1906) and 236 (1907)]. E. H. B.

267. *Theory of Cemented Doublets.* H. C. Lomb. (Astrophys. Journ. 24. pp. 263-267, Nov., 1906.)—Defines the function known as Abbe's Invariant.

268. *Influence on Vision of Optical Stimuli Variable in Time and Space.* E. Mach. (Akad. Wiss. Wien, Sitz. Ber. 115. 2a. pp. 633-648, May, 1906.)—Deals with the various phenomena obtainable by rotating discs with black and white segments and other kindred contrast effects. E. H. B.

269. *Origin of Colour.* I. E. C. C. Baly and A. W. Stewart. (Astrophys. Journ. 24. pp. 133-155, Oct., 1906.)—A general exposition of the bearing of the author's conception of isorropesis on the phenomena of colour and fluorescence. Possibly in the case of colour the isorropesis provides the mechanism and the incident light actuates it; in the case of fluorescence, the isorropesis both provides and actuates the mechanism. D. H. J.

270. *Tables for Theoretical Decay of  $\beta$ -radiation of Induced Radio-activity and of Radium Emanation.* P. Gruner. (Jahrbuch d. Radioakt. u. Elektrotonik, 3. 2. pp. 117-119, July 24, 1906.)

271. *Tables of Exponential Functions with Negative Exponents,  $y=e^{-x}$ .* P. Gruner. (Jahrbuch d. Radioakt. u. Elektrotonik, 3. 2. pp. 120-133, July 24, 1906.)

272. *Properties of Actinium.* T. Godlewski. (Jahrbuch d. Radioakt. u. Elektrotonik, 3. 2. pp. 184-187, July 24, 1906.)—Gives a bibliography and collected summary of the properties of and investigations carried out with actinium.

## HEAT.

**273. Coefficient of Expansion of Fused Quartz.** H. D. Minchin. (Phys. Rev. 24. pp. 1-21, Jan., 1907.)—The specimen tested was a ring 9.9 mm. high, and of diameters about 24 and 33 mm. The ring was heated in an electric furnace, and its expansion measured by an interferometer method, the ring being covered by a plate of fused quartz, and another, smaller, optically worked plate of the same material placed inside the ring on a base formed by a third plate. The expansion is measured at 100-degree intervals from 200° to 900°, the highest measurement being made at 950° C. Throughout the whole range from room temperature to 950° the expansion was uniform, and no after-effects were observed. The mean coefficient, deduced from 48 determinations, is  $44.9 \times 10^{-6}$ . The values found by le Chatelier ( $50 \times 10^{-6}$ ), Callendar ( $59 \times 10^{-6}$ ), and Holborn and Henning ( $54 \times 10^{-6}$ ), are discussed in relation to the methods and the purity of the specimens employed. The material for the experiments was supplied by Zeiss.

G. E. A.

**274. A Gas that sinks in a Liquid.** H. Kamerlingh Onnes. (Konink. Akad. Wetensch. Amsterdam, Versl. 15. pp. 454-455, Dec. 5, 1906. Proc., 9. pp. 459-460, Dec. 21, 1906. Communication No. 96 from the Physical Laboratory of Leiden.)—When a mixture of one part of helium with six parts of hydrogen in a glass tube is immersed in liquid hydrogen and submitted to pressure, liquid hydrogen appears in the lower part of the tube with a distinct concave boundary from the gaseous mixture above, so long as the pressure does not exceed 49 atmos. At this latter pressure the gas phase, consisting chiefly of helium, goes down just as water through oil and remains at the bottom as a large drop. With further compression to 60 atmos., and with decrease of pressure to 32 atmos. the volume of this drop or bubble appears to follow the gaseous law. At this lower pressure the bubble rises again, and by renewed alterations of pressure the phenomena can be made to recur. The temperature is about  $-268^\circ\text{C}$ . The connection between this phenomenon and van der Waals'  $\psi$ -surface is sketchily indicated and is to be more closely investigated; but it is concluded that for helium  $b$  is small and  $a$  exceedingly small—possibly even with a negative value.

R. E. B.

**275. Hygroscopic Action of Cotton.** O. Masson and E. S. Richards. (Roy. Soc., Proc. Ser. A. 78. pp. 412-429, Dec. 20, 1906.)—Further experiments on the absorption of moisture by cotton show that the amount of water required by a given quantity of cotton to put it in equilibrium with an atmosphere of given humidity, below the saturation value, can be ascertained by taking the mean of the apparent equilibrium values reached by absorption of initially dry cotton and by evaporation from supersaturated cotton, it being possible to follow either change by observing the characteristic temperature curve given by a thermometer, the bulb of which is covered by the cotton. The vapour tension of any sample of cotton containing a definite quantity of moisture is at different temperatures the same fraction of that of water, thus following Babo's law for aqueous solutions. Different

weights of the same cotton have the same vapour tension when they contain the same weights of hygroscopic moisture, the results being uninfluenced by tight or loose packing, and very similar whether for cotton-wool or filter-paper. A new method of hygrometry is suggested, based on the fact that the initial rise of temperature during absorption of moisture by dry cotton is directly proportional to the pressure of aqueous vapour. Thus it was shown [see Abstract No. 127 (1905)] that  $\theta [1 + (r^2/l)] = 2r\phi$ , where  $l$  = time since exposure of dry cotton,  $\theta$  = difference of temperature between the cotton and its environment;  $\phi$  = the max. value attained by  $\theta$ , and  $r$  is the corresponding value of  $l$ , so that at any moment  $l \, d\theta/dl = 2r\phi (r^2 - l^2)/(r^2 + l^2)$ , and therefore  $(d\theta/dl)_0 = 2\phi/r$ , whence  $\phi/r$  should equal  $k\phi$ , where  $\phi$  is the pressure of water vapour in the atmosphere surrounding the cotton, and  $k$  is a constant for the instrument, which consists of the thermometer and its cotton covering. This method is found to give fairly accurate results. A postscript is added to the paper comparing the results of Trouton and Pool's experiments on flannel [see Abstract No. 914 (1906)] with the authors' own. W. H. S.

276. *Emissive Power of Carbon.* A. Amerio. (Accad. Sci. Torino, Atti, 41. 15. pp. 788-794, 1905-1906. N. Cimento, 12. pp. 168-171, Sept., 1906.)—The carbon of luminous flames is shown to be grey for all that part of the spectrum from about  $\lambda = 0.4 \mu$  to  $\lambda = 1.5 \mu$ , whilst for longer waves it is still less absorbent. The fact that no luminous spot is observed when solar light is concentrated on the crater of the positive carbon of the voltaic arc does not prove that the carbon here acts as a black body, as this result admits of other possible explanations. [See also Abstract No. 1405 (1906).] T. H. P.

277. *Measurement of very Low Temperatures.* IX. H. Kamerlingh Onnes and C. A. Crommelin. (Konink. Akad. Wetensch. Amsterdam, Versl. 15. pp. 188-151, July 20, and pp. 865-867, Dec. 5, 1906. Proc., 9. pp. 180-198, Oct. 25, and pp. 408-405, Dec. 21, 1906. Communication No. 95a from the Phys. Lab., Leiden.)—This continuation of former work [see Abstract No. 1440 (1904)] deals with the comparison of a constantan-steel thermo-element with a hydrogen thermometer. Direct comparisons were made at 16 temperatures between  $-58.7^\circ$  and  $-259.8^\circ$  C. and 12 indirect comparisons within the range  $-29.8^\circ$  to  $217.9^\circ$  by means of a platinum-resistance thermometer. These temperatures were obtained in a cryostat by means of liquid methyl chloride, ethylene, oxygen, and hydrogen. The e.m.f. varied from 1252.8 microvolts at  $-29.8^\circ$  to 7158.5 at  $-259.2^\circ$ , and a five-term formula,  $e = at + bt^2 + ct^3 + dt^4 + et^5$ , was found to represent the e.m.f. to within 2 microvolts only down to  $-217^\circ$ , a sixth term being needed for lower temperatures to be included. This thermo-element is thus not suitable for measurements of the lowest temperatures. In the supplementary communication it is shown that a four-term formula (i.e., omitting  $t^5$ ) represents the experimental results equally well. R. E. B.

278. *Measurement of very Low Temperatures.* X. *Expansion of Fena and Thilringer Glass at Low Temperatures.* H. Kamerlingh Onnes and J. Clay. (Konink. Akad. Wetensch. Amsterdam, Versl. 15. pp. 151-159, July 20, 1906. Proc., 9. pp. 199-207, Oct. 25, 1906. Communication No. 95b from the Phys. Lab., Leiden.)—As a result of further determinations of the variation of resistance of platinum wires with the temperature, the authors have

arrived at certain corrections to their former figures [see Abstract No. 1425 (1905)]. Applying these, the values there given should read as follows:—

|                                   |                                                      |         |
|-----------------------------------|------------------------------------------------------|---------|
| Jena glass, 16 <sup>m</sup> ..... | $a = 7.81 \times 10^{-6}, b = 0.0090 \times 10^{-6}$ | } 1908. |
| Thüringer glass .....             | $a = 9.20 \times 10^{-6}, b = 0.0120 \times 10^{-6}$ |         |

Redeterminations made confirmed these values. Scheel's work, however [see Abstract No. 811 (1904)], together with the advisability of testing whether the great increase of  $b$  at low temperatures occurred with other solid substances, rendered it desirable to know the expansion of platinum. This was measured in the same way as for the glass rod, a new set of determinations of the coefficient of expansion of Jena glass and of platinum between 0° and -182° being obtained. With platinum the same strong increase of  $b$  is found, so that cubic equations must be used for the lengths in both substances when the expansion is required as far as -182°. The glass was the same as that used in the experiments of 1908. The following are the results:—

|                                   |                                                        |         |
|-----------------------------------|--------------------------------------------------------|---------|
| Jena glass, 16 <sup>m</sup> ..... | $a = 8.85 \times 10^{-6}, b = 0.0117 \times 10^{-6}$   | } 1905. |
| Platinum .....                    | $a = 9.058 \times 10^{-6}, b = 0.00494 \times 10^{-6}$ |         |

These figures are compared with those of other observers for ranges from 0° upwards. L. H. W.

**279. Measurement of very Low Temperatures. XI. H. Kamerlingh Onnes and J. Clay.** (Konink. Akad. Wetensch. Amsterdam, Versl. 15, pp. 160-165, July 20, 1906. Proc., 9, pp. 207-218, Oct. 25, 1906. Communication No. 95c from the Phys. Lab., Leiden.)—The platinum-resistance thermometer was compared with the hydrogen thermometer at temperatures between 0° and -259.24° C. obtained by cryostats as in Abstract No. 277 (1907). Neither a quadratic nor a cubic formula is sufficient to represent the results obtained at low temperatures, but a formula of the type—

$$R = a + bt + ct^2 + dt^3 + eT + fT^2$$

was found to be good for the whole range of temperature employed, and this gave a point of inflection for -180°, thus indicating the possibility of the resistance of platinum having a minimum value at some very low temperature. R. E. B.

**280. Measurement of very Low Temperatures. XII. H. Kamerlingh Onnes and J. Clay.** (Konink. Akad. Wetensch. Amsterdam, Versl. 15, pp. 166-169, July 20, 1906. Proc., 9, pp. 213-216, Oct. 25, 1906. Communication No. 95d from the Phys. Lab., Leiden.)—A gold-resistance thermometer was compared with a platinum-resistance thermometer, which [see preceding Abstract] had been itself compared with a hydrogen thermometer; the range of temperature was from 0° to -259.2° C. on the hydrogen scale. A formula of the type given in the preceding Abstract was found necessary to represent all the observations with fair harmony: it indicates the occurrence of a point of inflection for the resistance of gold at -220° and a minimum at not far off -259°. R. E. B.

**281. Measurement of very Low Temperatures. XIII. H. Kamerlingh Onnes and C. Braak.** (Konink. Akad. Wetensch. Amsterdam, Versl. 15, pp. 349-360, Nov. 7, 1906. Proc., 9, pp. 367-378, Nov. 22, 1906. Communication No. 95e from the Phys. Lab., Leiden.)—Detailed description of the



arrangement and use of a hydrogen thermometer, together with the necessary measurements and their reduction, for the purposes of determining very low temperatures is here given. It is concluded that with due care these may be measured to an accuracy of  $0.02^\circ$ . The vapour pressure of hydrogen at the melting-point is found to be 53.82 mm., which is 4.82 mm. more than that found by Travers, Senter, and Jaquero [see Abstract No. 1025 (1908)]. The zero-point pressure was found to diminish with time to a final condition, and was attributed to absorption of the gas by the glue used at the joints of the apparatus. R. E. B.

**282. Characteristic Equation.** H. Happel, (Ann. d. Physik, 21. 2. pp. 342-380, Nov. 8, 1906. Tübinger Habilitationsarbeit.)—This is the full paper of which part has already appeared [see Abstract No. 426 (1906)] wherein 0.2689 should be 0.2869. The particular form of equation of state there given, which is shown to be applicable to monatomic substances, is found to represent the behaviour of substances corresponding with ether if  $a$  and  $b$  are taken as particular functions of  $T$ ; and the general conclusion is drawn that the influence of association is to lower the vapour pressure. R. E. B.

**283. Characteristic for Ethyl Oxide.** A. Batschinski. (Ann. d. Physik, 21. 5. pp. 1001-1012, Dec. 14, 1906.)—For ethyl oxide the author deduces from Ramsay and Young's observations the characteristic :—

$$pv = 0.846(T - 7.9) - 6896000 T^{-2}(v - \epsilon)/v(v - \lambda),$$

where  $1/\epsilon = 1.010 - 0.000928 T$ ,  $\lambda = 1.2455 T/(114.73 + T)$ , pressures being measured in metres of mercury and volumes in c.cm. R. E. B.

**284. Wien's Constant.** M. Planck. (Deutsch. Phys. Gesell., Verh. 8. 24. pp. 695-696, Dec. 30, 1906.)—The product  $\lambda_m T$ , which on Wien's theory is constant, has been shown by the author to be equal to  $c/\beta$ , where  $\beta$  is the root of the equation  $\log(5 - \beta) = \log 5 - \beta$ , viz. 4.9651, and  $c$  is the constant in Wien's law  $E = a\lambda^{-5} \exp(-c/\lambda T)$ . With Holborn and Valentiner's value for  $c$ , viz.,  $14200 \mu$  [see Abstract No. 80 (1907)], we get  $b = 2860 \mu$ , which varies by only 2.4 per cent. from the value found by direct measurements of  $\lambda_m$ . R. E. B.

#### REFERENCES.

**285. Heating-power of Gases.** (Elekt. Runds. 23. pp. 544-547, Dec. 12, 1906, and 24. pp. 5-8, Jan. 3, 1907.)—A description, with method of use, of a new apparatus for determining the heating power of gases exploded with air. The machine is complicated in construction, and for details the original paper should be consulted. A. W.

**286. Van der Waals' Formula.** K. Fuchs. (Ann. d. Physik, 21. 4. pp. 814-824, Nov. 27, 1906.)—Justification is here sought for an extension of van der Waals' formula, which by a simplification applies to a liquid. E. H. B.

**287. Deduction of Wien's Law.** P. Ehrenfest. (Phys. Zeitschr. 7. pp. 850-862, Nov. 15, 1906.)—The author maintains the validity of his objection [see Abstract No. 2050 (1906)] to Jeans' deduction of this law, and calls for an argument on physical lines in justification of Jeans' purely mathematical hypotheses. J. H. Jeans. (Ibid. 8. pp. 91-92, Feb. 1, 1907.)—Jeans replies to the above. R. E. B.

measurements and their reduction for the purpose of determining the temperature is here given. It is concluded that with due care may be obtained a number of 0.01. The vapor pressure of hydrogen at the

## ELECTRICITY AND MAGNETISM.

### THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

**288. Shape of a Weightless Liquid Conductor in a Uniform Electric Field.** G. Jäger. (Akad. Wiss. Wien, Sitz. Ber. 115. 2a. pp. 928-940, June, 1906.)—The usual method of carrying out Plateau's beautiful experiment, showing the shape of a liquid from which the influence of its weight is withdrawn, consists in floating oil in a mixture of water and spirit. If the whole arrangement is included between the plates of a charged condenser the oil sphere is not found to change shape. This is explained by reference to the fact that the liquid mixture is a conductor of electricity so its interior is at a constant potential, hence no field acts on the oil. If, however, the glass vessel is filled with oil and a body formed in its midst of water and alcohol, then the electric forces act upon this water and alcohol sphere so soon as the glass dish is brought into an electric field. The paper then passes on to deal with the experiments made in this way, the results being represented by eight photographs of the forms thus obtained. The subject is also treated mathematically, the final conclusion being as follows: If a weightless conducting liquid sphere be brought into a uniform electric field which increases gradually from zero value, then the sphere assumes first the form of a rotation-ellipsoid; second, that of a rotation figure whose generatrix is a Cassini's curve. Later the form is one that cannot be geometrically specified; it next becomes unstable, and finally breaks up into a number of smaller figures. E. H. B.

**289. Negative Charge in Electric Field due to Ultra-violet Light.** Mme. Baudeuf. (Comptes Rendus, 143. pp. 1139-1141, Dec. 24, 1906.)—In this paper the author describes an effect obtained with negative electricity similar to that previously obtained with positively charged plates [see Abstract No. 89 (1907)]. The two phenomena are governed by the following law: When two metallic plates of suitable nature and state are raised to different potentials, creating between them a sufficiently intense electric field, certain ultra-violet rays, falling on the plate at the lower potential, cause the electric condition of the two plates to vary; the rays diminish the field to a final value which depends on the experimental conditions, and which is maintained so long as the conditions remain the same. A. W.

**290. Electrostatic Capacity of a Vertical Cylindrical Aerial.** A. E. Kennelly and S. E. Whiting. (Electrical World, 48. pp. 1289-1241, Dec. 29, 1906. Écl. Électr. 50. pp. 188-184, Feb. 2, and pp. 218-220, Feb. 9, 1907.)—The problem of calculating the electrostatic capacity between a long conducting cylinder and an infinite conducting plane at right angles to its axis presents considerable mathematical difficulty. The solution would be of practical importance, as it could be applied to the case of a cylindrical vertical antenna or aerial in wireless telegraphy. If we consider the wire as the limiting case of a prolate spheroid its capacity would be given by  $l/[2 \log(l/r)]$ , where  $l$  is the length of the aerial and  $r$  its radius. It is customary to assume that this formula will give the capacity between the aerial and the earth to a first rough approximation. It has to be remembered, however, that the equipotential

surfaces round the limiting spheroid are also spheroids, but in the practical problem the Faraday tubes are more numerous near the lower end of the aerial and the equipotential surfaces are squeezed together underneath it. The nearer a point on the aerial is to the ground the greater will be the density of the charge at that point. The authors have found experimentally how much the capacity between the aerial and earth exceeds the capacity of the limiting spheroid at a great distance from other conductors. They have done this by utilising the method of duality. The ohmic resistance between a vertical copper cylinder and a horizontal copper plate underneath it when both are immersed in a bath of copper sulphate was found for various lengths of the cylinder. As the capacity in the corresponding electrostatic problem is in a constant ratio to this resistance it can readily be calculated. In the following table the capacity  $K$  in centimetres (abstafarads) between a vertical conducting cylinder 100 cm. in diam. and the earth are given for various lengths of the cylinder when 80 cm. from the ground. The capacity  $K'$  is calculated by the formula given above and  $r = K/K'$ . The actual diameter of the copper cylinder experimented on was 0.25 cm., but as the capacities and resistances are proportional to the linear dimensions it is very easy to find them when all the linear dimensions are multiplied by 400.

| Length. | $K'$ . | $K$ . | $r$ . |
|---------|--------|-------|-------|
| 8,000   | 788.0  | 857.8 | 1.089 |
| 7,000   | 708.3  | 775.8 | 1.095 |
| 6,000   | 626.4  | 696.2 | 1.111 |
| 5,000   | 542.8  | 615.0 | 1.138 |
| 4,000   | 456.4  | 529.8 | 1.161 |
| 3,000   | 366.4  | 436.0 | 1.190 |
| 2,000   | 271.0  | 338.5 | 1.250 |
| 1,000   | 166.9  | 217.6 | 1.304 |

It is interesting to notice that according to these measurements the capacity of a cylinder the length of which is 80 times its diam. is only 8.9 per cent. greater near the ground than in free space. Even if the height be reduced to 10 diams. its capacity is only 8.0 per cent. greater near the ground than in free space. Several causes made it difficult to obtain very accurate results. In the first place, the dimensions of the copper disc at the bottom of the tub were too small to more than approximately represent an infinite conducting plane. The conductances, and therefore also the calculated capacities, were probably too small. Secondly, it is difficult to avoid errors in the measurement of a resistance containing a counter e.m.f. of polarisation even when working to polarisation-zero. Moreover, if the polarisation varies with the current density, some variation of the polarisation e.m.f. may have developed at different portions of the exposed surface. Consequently errors of a few per cent. in the measurements may be due to this cause. The results, however, may be safely regarded as indicating that in the case of a vertical insulated cylinder not too near the ground, having a length of 100 or more diams., its capacity will only be a few per cent. greater than that obtained by the use of the ellipsoidal formula given above. By means of an exploring electrode, consisting of a copper wire sealed in a glass tube, the authors, by an extension of Kirchhoff's method, mapped out the equipotential surfaces in the liquid. Hence the approximate shapes and positions of the Faraday tubes can be seen at once from the diagram they give.

A. R.

## DISCHARGE AND OSCILLATIONS.

291. *Ratio of the Energy of Röntgen Rays to that of the Exciting Kathode Rays.* E. Carter. (Ann. d. Physik, 21. 5. pp. 955-971, Dec. 14, 1906. Extract from Dissertation, Würzburg. Écl. Electr. 50. pp. 184-185, Jan. 26, 1907).—Relative values of the energy of the kathode rays under different conditions are found by making the antikathode the base of a small glass tube which contains water. The rise in temperature caused by the bombardment is taken as a measure of the energy, the same mass of water being used in each experiment. The relative values of the energy of the Röntgen rays are found by two methods—in the first by the temperature-rise they cause in a bolometer on which they are allowed to fall. In the second method the radiation falls on an insulated sheet of platinum in a highly exhausted vessel; this metal emits kathode rays under its influence, and therefore gains a positive charge. This charge, as measured by an electrometer, is taken as a measure of the energy of the Röntgen radiation. If  $E_R$  and  $E_K$  represent the energy of Röntgen and kathode rays respectively, it is found that the ratio  $E_R/E_K$  does not depend on the strength of the primary current in the induction coil, but is directly proportional to the voltage at the tube [see Abstract No. 815 (1907)]. It is independent of the character and number of the interruptions of the primary current, and, in fact, has the same value when an influence machine is used. The ratio is generally larger for metals of higher atomic weight, but platinum gives results the large variations in which cannot be accounted for. R. S. W.

292. *The Aluminium Condenser and Production of Duddell Currents.* O. M. Corbino and S. Maresca. (N. Cimento, 12. pp. 5-84, July and Aug., 1906. From Atti dell' Assoc. Elett. Ital., July, 1906. Electrician, 58. p. 418, Dec. 28, 1906. Abstract).—A lengthy investigation of the electrical properties of the aluminium cell. The relation between capacity and applied formation p.d. is examined, and the capacity at p.d.'s below those of formation, also the residual internal conductivity of the plate at various formation voltages. For these results the original should be consulted. To obtain a further insight into the working of the cell, experiments were made to see if Duddell currents could be obtained. It is found that a singing arc can be obtained with a condenser having a kathode of lead, platinum, or aluminium, and the general character of the phenomenon is very similar to that found by Corbino with ordinary condensers [see Abstract No. 1041 (1906)]; with increase of current in the arc the frequency rises. Using an inductance of 6.9 millihenrys and a formed anode of 800 cm.<sup>2</sup> immersed surface, oscillations were obtained giving a sound up to the pitch corresponding to 440 complete vibrations per sec. The frequency obtained on inserting inductance is practically in agreement with the conditions of resonance. The capacity calculated from considerations of resonance is 23 mfd., and is identical with that obtained with a constant applied p.d.; hence the film preserves its capacity unaltered at this high frequency. It is further found that an ammeter inserted in the arc circuit gives a deflection indicating a current, up to 0.2 amp., opposed to that due to the p.d. between the arc electrodes; and hence the arc is traversed by a mean current which is greater than the current in the supply circuit; a Mascart electrometer also showed that the p.d. across the inductance is greater than the p.d. across the arc electrodes. On substituting for the neutral kathode another formed aluminium plate, the pitch of the note emitted is found to rise considerably, indicating that the capacity of the

condenser is reduced to half. The film thickness, assuming  $k=5$ , is found to be  $0.05 \mu$  and  $0.01 \mu$  for formation voltages of 150 and 80 volts respectively; the pressure per unit of area at the former voltage is thus equivalent to 2,000 atmos., and the dielectric rigidity is about 8,000 kilovolts per mm.

L. H. W.

293. *Positive Kathode Particles.* P. Villard. (Comptes Rendus, 148. pp. 874-878, Nov. 5, 1906.)—After the ordinary kathode rays have been bent out of the way by a magnetic field, there is a residue of rays which are not perceptibly deflected, and which give the hydrogen or oxygen spectrum. The author proves by magnetic and electrostatic deflection that these rays consist of positively charged particles.

E. E. F.

294. *Effect of Radiations on the Sparking Potential.* J. Herweg. (Phys. Zeitschr. 7. pp. 924-926, Dec. 15, 1906. Écl. Électr. 50. pp. 58-59, Jan. 12, 1907.)—Warburg considers that the effect of ultra-violet light on the spark is only to reduce the retardation of the discharge and not the sparking potential [see Abstract No. 2245 (1902)]. While the author's results agree with those of Warburg in the case of relatively weak ionisations, if the radiation intensity is made stronger, and hence the number of ions considerably increased, an actual reduction of the sparking potential results from the radiation. The experiments were made with ultra-violet light, kathode rays, and the point discharge of a Tesla transformer. As voltage source an influence machine charged one spark-ball, through a variable very high resistance, slowly to the point at which discharge took place, the other spark-ball and the free pole of the influence machine both being earthed. Voltages were read by means of a Braun electrometer. With ultra-violet light from a zinc arc 8 cm. from the spark-gap the sparking voltage with a 3 mm. gap was reduced from 11,850 to 10,700 volts immediately the arc was started. With kathode rays from a tube whose window was  $\frac{1}{4}$ - $\frac{1}{2}$  mm. away from the gap the results exemplified in the following table were obtained:—

| Spark-gap. | Sparking Voltage.     |        |                    |       |
|------------|-----------------------|--------|--------------------|-------|
|            | Without Kathode Rays. |        | With Kathode Rays. |       |
| 3 mm.      | 11,100                | 11,100 | 6,100              | 5,900 |
| 2 "        | 8,200                 | 8,850  | 3,500              | 3,850 |
| 1 "        | 4,800                 | 4,800  | 2,200              | 2,200 |
| 2 "        | 8,850                 | 8,200  | 3,850              | 3,850 |
| 3 "        | 10,950                | 10,950 | 5,850              | 5,200 |

It will be seen that the reduction in sparking voltage is considerable, and that the sparking voltages obtained without kathode rays are in agreement with those of Heydweiller-Paschen; they are very nearly the same whether the electrometer is charged + or —. On a metal plate being placed in front of the kathode-ray tube window the ordinary sparking voltages were obtained, showing that the effect is not due to the Tesla transformer employed. The point discharge produced a similar but not so marked effect.

L. H. W.

295. *Energy Necessary to Ionise a Molecule.* B. Davis. (Phys. Rev. 24. pp. 98-102, Jan., 1907.)—Townsend has determined the number of ionising



collisions experienced by a negative ion under different pressures while it traverses 1 cm. [see Abstract No. 1084 (1905)]. From these results the author calculates the least value of  $\chi\lambda$  to produce ionisation, where  $\chi$  is the field and  $\lambda$  the path over which the ion moves freely in this field. The assumptions made for the purpose of the calculation are that the molecules are spheres, and that ionisation is produced every time an ion collides with a molecule, provided the velocity normal to the surface of the sphere exceeds a certain value. A test of the theory is provided by the constancy or inconstancy of  $\chi\lambda$ ; using Townsend's results, this varies between 11.4 and 13.6 volts.

R. S. W.

296. *Sliding Sparks*. M. Toepler. (Ann. d. Physik, 21. 2. pp. 198-222, Nov. 8, 1906. Phys. Inst. d. techn. Hochschule, Dresden, July 25, 1906. Écl. Electr. 49. pp. 460-463, Dec. 22, 1906.)—The author studies in detail a special form of stratified discharge along the surface of a clean plate of glass or mica, on the other side of which a strip of tin-foil 2 cm. in width is stuck as a guide to the discharge [see Abstract No. 174 (1898)]. A high discharge potential is obtained from a 60-plate influence machine provided with two capacities of 80,000 cm. each, shunted through a water resistance of 8 megohms. One of the terminals was connected with the tin-foil, while the other touched the bare glass. The "positive" spark-length (obtained when the anode is on the bare glass) shows a sudden increase after a certain potential, the negative spark-length does not. The length of positive gliding brushes is proportional to the fourth power of the voltage. It shows only one stalk, and in this stalk the product of the resistance into the quantity of electricity expended is constant during the formation of the brush. If the resistance is measured in ohms and the quantity in coulombs the product has a numerical value  $0.8 \times 10^{-9}$ . The author explains this by considerations of ionisation.

E. E. F.

297. *Oscillatory Discharge of Polarised Cells*. F. Krüger. (Ann. d. Physik, 21. 4. pp. 701-755, Nov. 27, 1906.) The theory of the oscillatory charge and discharge of polarised cells is developed and the results are confirmed by experimental examination of discharge curves of polarised cells, taken immediately on the current being cut off, by means of a Helmholtz pendulum interrupter. Mercury electrodes in normal  $H_2SO_4$ , saturated with  $HgSO_4$ , show, even with large self-induction in circuit, always an aperiodic discharge, since in this case strong diffusion is predominant. In solutions of normal  $Na_2S$ , saturated with  $HgS$ , however, the discharge on increasing the self-induction changes from the aperiodic into the oscillatory; the effect of diffusion is small in this case. From the formula for the periodic time the capacity of mercury electrodes is about 10 mfd. in this solution at 253 semi-oscillations per sec. Platinum electrodes in normal  $HCl$  and 80 per cent.  $H_2SO_4$  give discharge curves which are hardly distinguishable from those of a condenser discharge except for the greater damping due to resistance. Oscillations up to 50,000 alternations per sec. were obtained, which come near the limit of capacity of the interrupter. The max. number of pole-changes observed before the oscillations die out is 14. The capacity of platinum between 2,000 and 5,000 alternations per sec. is calculated as 9 mfd./cm.<sup>2</sup>, and for palladium 8 mfd./cm.<sup>2</sup> Palladium electrodes having only one side dipping into the electrolyte, give an aperiodic discharge when the other side is strongly charged with hydrogen, by means of a strong reducing

agent; on the other hand, when this side is given a potential midway between that of the H- and the O-electrode, by means of a reducing or oxidising agent, an oscillatory discharge is obtained. L. H. W.

### ELECTRICAL PROPERTIES AND INSTRUMENTS.

298. *Photo-electric Action at Low Temperatures.* A. Lienhop. (Ann. d. Physik, 21. 2. pp. 281-304, Nov. 8, 1906. Extract from Dissertation, Kiel.)—In his research on photo-electric action [Abstract No. 1888 (1902)] P. Lenard investigated the effects of the incidence of light of short wave-length on metal surfaces and found that the quantity of electricity discharged was proportional to the intensity of the incident light, provided the quality remained the same. The initial velocity of the discharged ions is independent of the intensity of the light, but varies with its quality. If the phenomenon depends on what goes on within the atom it may be expected to be independent of the temperature, and the investigation described in the present paper was undertaken to decide this question. It was found that with temperatures varying from that of an ordinary room to that of boiling liquid-air the phenomena referred to were independent of the temperature, indicating that the effects concerned were not those of molecular or intra-molecular motions, but depended on the internal energy of the atoms. J. J. S.

299. *Constancy of Thermo-elements.* W. P. White. (Phys. Rev. 23. pp. 449-474, Dec., 1906. Electrician, 58. p. 606, Feb. 1, 1907. Abstract.)—An account is given of a new method of testing the thermoelectric power of wires by the use of one or more exploring wires which touched the wire examined within the heated portion. This auxiliary wire is of the same material as the wire under test. Some new facts as to the source of error in thermo-elements at high temperatures and the causes of contamination which occurred were discovered. The following is a summary of the principal points in the paper: (1) The main source of error in thermo-elements is inhomogeneity, by the removal of which in most cases far greater accuracy may be attained than has hitherto been realised. (2) The e.m.f. of an inhomogeneous element equals  $\int \theta dH$ , where  $\theta$  = temperature and  $H$  = thermoelectric power. This formula can be applied by a convenient graphical method. Errors due to inhomogeneity can be made to decrease indefinitely as the temperatures remote from the junctions of the element are made more constant, as these errors depend also upon the temperature distribution along the element. (3) Thermoelectric wire-testers of several easily constructed types are most helpful in studying thermoelectric properties of wires and in making thermo-elements. (4) The effect of initial chemical inhomogeneity is practically negligible as far as thermo-element work is concerned in (Heraeus') thermo-element platinum wires, in commercial copper, and often, if not always, in constantan. (5) The effect of physical inhomogeneity (variation of hardness) in these wires can by no means be neglected. This hardness, as well as that which may result from bending, &c., can be quickly and effectually removed from platinum wires by annealing. In constantan thorough hardening also produces uniformity, and leaves the metal nearly free from liability to further change through handling. (6) Constantan and copper wires are apt to become chemically inhomogeneous through the formation of a film of oxide. An error of 0.5 per cent. may develop from this cause at ordinary temperatures within a few months.

Cleaning off the film produced nearly, if not quite, restores the original condition. (7) Platinum at high temperatures takes up impurities which diffuse into the wire. Carbon, illuminating gas, &c., produce this result only through their reducing action on other substances capable of injuring the platinum, of which iron, which reaches the platinum in the form of vapour, and silicon are perhaps the most important. In an oxidising atmosphere silicates and iron oxides are harmless, but contamination occurs above  $900^{\circ}$  from the presence in the hot furnace of small quantities of rhodium, and especially iridium, either pure or in alloys with platinum. All of these metals are somewhat volatile at high temperatures. The contaminating impurity cannot be removed, but can be excluded by inclosure in glazed Marquardt porcelain, which, moreover, is fairly durable at  $1,500^{\circ}$ . (8) Where the use of contaminated elements is necessary, fair accuracy can still be obtained by frequent comparison with standards under conditions such that the temperature gradient along the contaminated wire is always the same. Frequent comparisons of platinum elements are always desirable in order to control the calibration and the unavoidable extrapolation. (9) Thermo-elements of platinum-rhodium and of constantan-copper, when used with proper precautions, have been found free from any error as great as 0.005 per cent. With the platinum this amounts to less than  $0.05^{\circ}$  at  $1,000^{\circ}$ ; with constantan, to less than  $0.002^{\circ}$  for measurements up to  $40^{\circ}$ . Moreover, this result with constantan was obtained with rather inferior wire, by uniting elements in series in such a way that the variations along the wires counteracted each other. J. J. S.

300. *Electro-capillary Function.* II. and III. Gouy. (Annal. Chim. Phys. 8, pp. 291-363, July, and 9, pp. 75-189, Sept., 1906.)—II. The author has continued his study of electro-capillary curves. Formerly he dealt with inorganic compounds, and with certain organic acids and their salts [see Abstracts Nos. 168 and 1484 (1908)]; he now deals with neutral organic bodies (alcohols, ethers, aldehydes, ketones, amines, nitriles, amides, carbohydrates, and glucosides) and organic acids in general. The method is much the same as before; as the bodies studied are bad conductors, a conducting aqueous solution (sodium sulphate in water) is used as solvent, and the electro-capillary curve is first determined for this solvent: the experimental substance is then added and the electro-capillary curve of the modified solution traced out. A comparison of the two curves gives the effect produced by the dissolved substance; where there is a difference, it is always a depression of the electro-capillary curve of the solvent by the organic body. The degree of activity in depressing the maximum capillarity varies greatly amongst the organic bodies studied, but in some cases is very marked, even in the case of bodies which are only slightly soluble. Quantities less than 1 gm. per litre may depress the maximum several cm. III. In the third part the author studies the electro-capillary curves of: (1) Strong bases; (2) bases of the aliphatic series of medium or low strength; (3) bases of the aromatic series; (4) ammonium salts. The displacement of the maximum by change of concentration and the effect of small proportions of added water are also shown. The results do not admit of satisfactory abstraction. D. H. J.

301. *Capacity and Resistance of Aluminium Anode Films.* C. McC. Gordon. (Phys. Rev. 24, pp. 60-71, Jan., 1907.)—With the aid of the Nernst-Gordon bridge-telephone method [see Abstracts Nos. 1142 (1906) and 2140 (1908)] the author hoped to measure both the resistance and the capacity

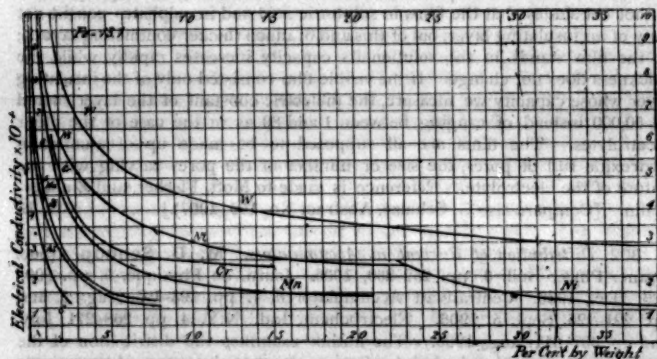
with the continuous current on or off; but the resistance of the film is too large, and it was determined by other methods further to be described. The anode is a strip of sheet Al, 1 cm. in width, dipping from 1 to 4 cm. into the electrolyte; the kathode, also of Al, is twenty times as large. The capacity is influenced by the surface polish; surfaces cut under turpentine give the smallest capacities; at higher voltages these differences, which seem to be due to differences in surface area, become less noticeable. Most of the experiments were made with commercial smoothly polished Al. Tubular electrodes at about 0° C. give the same capacities as sheet anodes; when the formation current of water-cooled tubular electrodes is turned off, the capacity increases more than with uncooled electrodes. The critical voltage decreases with rising temperature, but there is hardly any change in the capacity between 15 and 25° C. Capacity tests with the current on had been made by Scott in 1889, but only for voltages up to 1.75. The author finds that the capacity varies inversely as the formation voltage, the product of formation voltage and capacity being about 38 in  $\text{HNaNH}_4\text{PO}_4$ , and about 38 in  $\text{K}_2\text{Cr}_2\text{O}_7$ , for formations ranging from 20 to 100 volts. While the critical voltage in sulphuric acid is 20 or 30 volts, and in citric acid 500 volts, the capacities in different electrolytes were about 0.35 mfd. per cm.<sup>2</sup> at formation voltage 20, and about 0.07 mfd. at 100 volts. Only  $\text{H}_2\text{SO}_4$  and  $\text{Na}_2\text{SO}_4$  gave higher capacities, 0.50 and 0.39 respectively, at 20 volts. These larger values are supposed to be due to the more rapid dissolution of the film in the sulphuric acid and sulphate. In most electrolytes the capacity remained fairly steady for 5 min. after turning off the forming current, but not in sulphuric acid. Insulating films are also formed in the fused nitrates of Na and K; the capacities are small, but increase so rapidly after cutting off the current (from 0.06 mfd. after 5 sec. to 1.05 mfd. after 105 sec.) that no minimum tests could be made; the films seem to dissolve rapidly. The author concludes that the films in sulphuric acid and in sulphates consist not only of an insulating layer, but of this and of much thicker conducting layers; as the film stands in the solution its capacity increases rapidly while the thickness does not change. If the visible film consisted only of the insulating layer whose capacity we measure, the dielectric constant of the layer should be 50,000 instead of ranging between 1 and 80 as in the case of the other electrolytes. The films are all supposed to be made up of aluminium hydroxide full of pores, the size or number of the pores varying with the nature of the electrolyte. Reference is made to Mott, Fischer, and Zimmermann. [Compare also G. Schulze, Abstract No. 156 (1907).] H. B.

302. *Distribution of Current in Accumulators.* M. U. Schoop. (Soc. Franc. Phys., Bull. 8. pp. 252-260, 1906. Journ. de Physique, 5. pp. 800-826, Dec., 1906. Centralblatt Accumulatoren, 7. pp. 198-195, Aug. 5, and pp. 221-225, Sept. 5, 1906. Electrochem. Ind., N.Y. 4. pp. 268-271, July, and pp. 307-311, Aug., 1906.)—The author examines the distribution of the lines of current in the electrolyte of an accumulator by means of two minute search electrodes of spongy lead, close together and joined to a galvanometer. On these electrodes being immersed in the electrolyte, and the whole system turned round an axis midway between the electrodes until no deflection is shown on the galvanometer, the plane of the electrodes is evidently that of an equipotential line, and hence the lines of current are perpendicular to this plane. This arrangement is employed to demonstrate several points connected with the working of cells, among which the falling off in capacity of the lower portion of spongy lead plates may be mentioned. The greater

action on the plate at its lower part is confirmed by the investigation of the lines of current; and that this action is chiefly due to the electrolytic shunt and not to inequality of the electrolyte density is supported by a further experiment. The method is also recommended for examining whether both sides of a plate are working at the same rate; in this case the two search electrodes are placed one on each side of, and at exactly the same distance from, the plate to be examined. If the galvanometer shows a deflection, the electrode joined to the + pole of the galvanometer is receiving too great a proportion of the current lines. L. H. W.

303. *Comparison of Capacities.* A. Trowbridge and A. H. Taylor. (Phys. Rev. 28, pp. 475-488, Dec., 1906.)—The authors have experimentally proved that the ratio of two good mica condensers is the same whether compared by direct or by alternating currents, provided that proper precautions be taken to eliminate the effect of absorption. It is also shown that distributed capacity in high-grade resistance boxes whose coils have brass cores causes a serious error in alternating-current measurements; an error which may be much reduced by using boxes whose coils are wound on wooden cores. A new circuit for the comparison of capacities and of inductances has been devised, which is more nearly free from errors due to distributed capacity than is the regular Maxwell bridge. [See also Abstracts Nos. 365 and 762 (1906).] F. E. S.

304. *Electrical Conductivity of Alloys.* W. Guertler. (Zeitschr. Anorg. Chem. 51. 4, pp. 397-433, Dec. 18, 1906. Metallog. Communication from the Inst. f. anorg. Chemie der Univ., Göttingen.)—The collation of literature, supported at points by hitherto unpublished results, leads the author to the

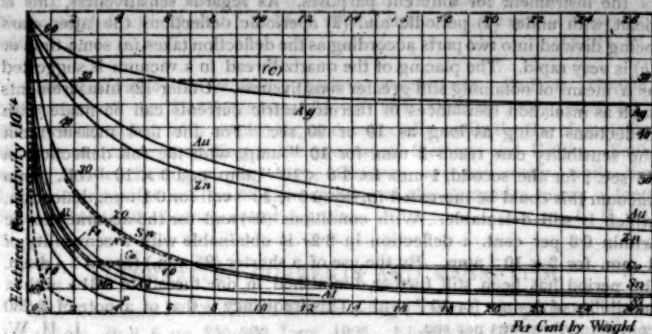


IRON WITH VARIOUS ADDITIONS.

following generalisations:—(1) Those alloys whose electrical conductivity is linear function of the volume-concentration of the two constituent metals show no notable (0.05 per cent.) solid solubility; and *vice versa*. (2) The electrical conductivity of alloys which form a continuous series of mixed crystals, follows a smooth curve with a very low minimum; and *vice versa*. (3) In the case of limited solid solubility, rule (1) applies to the saturated mixed crystals as to pure metals; rule (2) applies to conductivity and con-



centration relations between the pure metals and saturated mixed crystals. (4) If in a series of alloys of two metals there be  $m$  compounds, then the electrical conductivity curves can, like the thermal equilibrium curves, be divided into  $m + 1$  binary systems, each of which falls under one of the laws (1) to (8). (5) The conductivity in a series of binary alloys can never be higher than the straight line joining the conductivities of the component



COPPER WITH VARIOUS ADDITIONS.

metals. It is shown that the absence of a peak in the curve of conductivity does not necessarily indicate the absence of compounds, but a peak in the curve undoubtedly corresponds with a compound. The following table shows compounds indicated by the consideration of conductivity curves, and the diagrams show the influence of additions of elements to iron and copper respectively. Numerous curves and references are given.

| Series.               | Compounds indicated by Study of Constitution.    | Compounds indicated by Study of Conductivity. |
|-----------------------|--------------------------------------------------|-----------------------------------------------|
| Gold-Tin .....        | AuSn (proved) .....                              | AuSn (probable)                               |
|                       | AuSn <sub>2</sub> (proved) .....                 | AuSn <sub>2</sub> (proved)                    |
|                       | AuSn <sub>4</sub> (proved) .....                 | AuSn <sub>4</sub> (probable)                  |
| Gold-Lead .....       | Au <sub>2</sub> Pb (proved) .....                | Not experimented upon                         |
|                       | AuPb <sub>2</sub> (proved) .....                 | AuPb <sub>2</sub> (probable)                  |
|                       | Possible .....                                   | AuPb <sub>4-6</sub> (probable)                |
| Silver-Tin .....      | Ag <sub>3</sub> Sn (proved) .....                | Not experimented upon                         |
| Copper-Tin .....      | Cu <sub>3</sub> Sn (proved) .....                | Cu <sub>3</sub> Sn (proved)                   |
|                       | Cu <sub>2</sub> Sn (proved) .....                | Cu <sub>2</sub> Sn (proved)                   |
| Copper-Antimony ..... | Cu <sub>2</sub> Sb (proved) .....                | Cu <sub>2</sub> Sb (proved)                   |
|                       | Cu <sub>3</sub> Sb (proved) .....                | Cu <sub>3</sub> Sb (proved)                   |
| Copper-Zinc .....     | Cu <sub>2</sub> Zn <sub>3</sub> (probable) ..... | } A compound, formula as yet uncertain        |
|                       | or CuZn <sub>3</sub> (possible) ...              |                                               |
| Antimony-Lead...      | Not experimented upon                            | SbPb                                          |
| Antimony-Tin ...      | SbSn .....                                       | SbSn (possible)                               |

F. R.

305. Further Researches on the Applications of the Chord-Galvanometer. W. Einthoven. (Ann. d. Physik, 21. 8. pp. 488-514, Nov. 20, and 4.

pp. 665-700, Nov. 27, 1906. From the physiolog. Laborat. d. Univ., Leiden.)—The theory and applications of the galvanometer are more fully dealt with [see Abstract No. 2261 (1905)], the following being the chief sectional headings: Mass of the thread, Resistance to the quartz thread's movement, Acceleration of the thread, Analysis of some curves, Absolute value of the mass and resistance to movement of the thread, Suitability of the instrument for different purposes. As regards sensitiveness, this is dealt with under (1) periodic and (2) aperiodic deflections, the latter class being divided into two parts according as the deflection takes (a) some time or (b) is very rapid. The placing of the quartz thread in a vacuum is suggested as a means of obtaining still greater sensitiveness. Under (2) measurements such as insulation resistances or thermoelectric currents can be made with deflections taking as long as 10 or 20 sec. For the first measurement the sensibility can reach 1 mm. for  $10^{-11}$  amp. with the full deflection in 15 sec.; for the second, 1 mm. for  $1.6 \times 10^{-11}$  amp. or  $1.6 \times 10^{-7}$  volt. In a vacuum this could be increased to, say,  $0.6 \times 10^{-8}$  volt for 0.1 mm. deflection, which is still detectable. With conditions (2b) and for the accuracy to be within 0.8 per cent. a deflection in  $2.2\sigma$  is obtainable with a sensibility of 1 mm. for  $3 \times 10^{-7}$  amp. By the use of a shorter (25 mm.) thread  $1\mu$  diam. the period has been still further diminished, in one thread to 0.81  $\sigma$  with a sensibility of 1 mm. for  $10^{-7}$  amp. This frequency is that of a note of 3,280 complete vibrations per sec. L. H. W.

306. *Rotating Interrupter for Capacity and other Measurements.* F. Kurlbaum and W. Jaeger. (Zeitschr. Instrumentenk. 26. pp. 825-829, Nov., 1906. Communication from the Physikal.-Techn. Reichsanstalt. Electrician, 58. p. 452, Jan. 4, 1907. Abstract.)—The special features of this interrupter are, the arrangements provided for adjusting the ratio of the duration of contact to the interval between successive contacts, and for counting the number of contacts in a given time. The contact wheel consists of two coaxial discs of brass insulated from each other by an ebonite disc; each brass disc has 80 ebonite segments let into its periphery, so that connection is made between two diametrically opposite pairs of brushes 80 times per revolution. The spindle carries a worm which engages with a worm wheel on which are mounted a series of brass pins projecting from its edge and parallel to its axis; a fixed brush makes contact with these and enables the revolutions of the interrupter to be counted electrically. J. D. C.

307. *A Self-acting Interrupter.* C. Ries. (Phys. Zeitschr. 7. p. 899, Dec. 1, 1906.—Two narrow rods of carbon are fastened one to the positive and the other to the negative pole of an accumulator (8 volts.) They are placed parallel to one another and about 1 mm. apart. Resting across these rods is a third rod of carbon; this arrangement acts very well as an interrupter. E. C. C. B.

308. *New Form of Radiometer.* W. W. Coblentz. (Phys. Rev. 22. pp. 358-359, June, 1906. Abstract of paper read before the Amer. Physical Soc.)—A radiometer having a much shorter period than the ordinary radiometer is obtained by superposing the radiometer effect upon a thermogalvanometer arrangement in a vacuum. The thermo-junction is made the vane of the radiometer. The half period is given as 5 sec. The sensitiveness is stated to be great but is not given. L. H. W.

309. *Mechanically-operated Electrolytic Interrupter.* R. Goldschmidt. (Soc. Belge Élect., Bull. 24, pp. 16-18, Jan., 1907.)—Although called an electrolytic interrupter by the author, the apparatus described really consists of a mechanically driven paddle-wheel of lead dipping into dilute sulphuric acid and forming one terminal, the other being a lead plate in the acid bath. It is found that with such an arrangement no sparking whatever takes place as each paddle, on emerging from the electrolyte, breaks the main current. No heating effect is observable either, even if the coil condenser is dispensed with. L. H. W.

310. *Röntgen-ray Tubes with Thorium Antikathode.* (D.R.P. 176,008. Elektrotechnik u. Maschinenbau, 24, p. 984, Dec. 2, 1906. Abstract.) Röntgen-ray tubes with electrodes, and especially antikathodes, of metallic thorium are made according to the process of Siemens and Halske. Such tubes, besides having a very high efficiency, are not costly, while the high melting-point and small disintegration of the electrodes insure a long life and hinder the occurrence of deposits. L. H. W.

### ALTERNATING CURRENTS AND MAGNETISM.

311. *Resistance of Conductors to Alternating Currents.* Brylinski. (Soc. Int. Élect., Bull. 6, pp. 255-300, June, 1906. Electrician, 57, p. 970, Oct. 5, 1906.)—Kelvin and other authors have given a complete solution of this problem for simple alternating currents. The author has extended the investigation to complex and damped oscillations on account of their importance in wireless telegraphy. Starting from Maxwell's formula it is found convenient to adopt an auxiliary variable  $\alpha = 2n\mu\pi^2 a^2/\rho$ ; where  $\rho$  = resistivity,  $\mu$  = permeability,  $a$  = radius,  $l$  = length of conductor considered in which a current of frequency  $n$  is flowing. If, then, A and B represent the following infinite convergent series—

$$A = \sum_{n=0}^{\infty} \frac{(-1)^n \alpha^{2n+1}}{(2n)!(2n+1)!}, \quad B = \sum_{n=0}^{\infty} \frac{(-1)^n \alpha^{2n+2}}{(2n+1)!(2n+2)!}$$

one finds the values—

$$R_1 = \frac{Ra}{2} \frac{d}{da} \left\{ \log (A^2 + B^2) \right\}; \quad L_1 = L - \mu l \left\{ \frac{1}{2} + \frac{d}{da} \left( \tan^{-1} \frac{A}{B} \right) \right\}$$

for the resistance and inductance. These formulæ are somewhat difficult to discuss. Luckily, however, by use of a table given by Kelvin it is possible, in the case of the resistance, to trace a curve for which the abscissæ are given by  $x = 2\sqrt{a}$ , and the ordinates  $y = R_1/R$ . For values of  $n$  between 0 and 1,  $y = 1$ . For values of  $n$  equal to or greater than 8, the curve is very approximately  $y = (x\sqrt{2} + 1)/4$ . For values of  $n$  between 1 and 8 the curve is represented by  $y = 0.0788x^3 - 0.1559x + 1.0771$ . *Complex Oscillations.*—Suppose the current consist of a number of superposed oscillations one of which has frequency =  $p$ -times the fundamental and effective value  $I_p$ . The Joulean heat is then  $\Sigma R y_p I_p^2$  per unit time, where  $R$  is ohmic resistance, and  $y_p$  its coefficient of variation with frequency. Also  $y = \Sigma y_p I_p^2 / \Sigma I_p^2$  from which the author obtains the result  $y = 1/4 + \sqrt{(a/2)} \Sigma p^{-3/2} / \Sigma p^{-2}$ . On giving  $p$  the values 1, 3, 5, 7, he gets, for this particular case,  $y = 1/4 + 1.14 \sqrt{(a/2)}$ , and if  $a$  is so great that we may neglect the term  $1/4$  we have simply  $y/y_1 = 1.14$ . In wireless telegraphy the oscillation is not, however, purely formed of har-

monics, but is usually composed of two oscillations of nearly equal period. In this case we have  $y = (y_1 I_1^2 + y_2 I_2^2) / (I_1^2 + I_2^2)$ . If the effective currents be supposed equal this becomes  $y = (y_1 + y_2) / 2$ . In the case where the one frequency is three times the other we have, when  $a$  is great,  $y = 1.86y$ . *Damped Currents.*—The author proceeds to a thorough mathematical discussion of the distribution of damped currents in an infinite mass of conductor bounded on one side by a plane surface, and arrives at the following results: (1) Whatever finite value the damping may have, the distribution of current is *always* superficial. (2) The current density diminishes very rapidly as the depth increases, and consequently the current is practically localised in a layer of definite thickness. (3) Damping causes a somewhat complicated distribution of the current at various depths. In the upper layer the density diminishes much more rapidly than with undamped currents. Then, at a certain depth, the density commences to diminish more slowly than for uniform currents. Further down there is another layer in which the diminution is very rapid, and so on.

The following table shows the ratio of the current density of uniform (undamped) currents at given depths, to that at the surface, in soil of resistivity  $66 \times 10^{11}$  c.g.s., and unit permeability:—

| Depth, in Metres | $2\pi n = 150.$ | $2\pi n = 4,000.$ | $2\pi n = 10^7.$ |
|------------------|-----------------|-------------------|------------------|
| 1                | 0.999           | 0.994             | 0.78             |
| 5                | 0.994           | 0.97              | 0.21             |
| 10               | 0.99            | 0.94              | 0.04             |
| 50               | 0.94            | 0.78              | 0.0000001        |
| 100              | 0.88            | 0.54              | "                |
| 1,000            | 0.80            | 0.006             | "                |
| 4,000            | 0.008           | 0.006             | "                |

For salt water of resistivity  $378 \times 10^9$  c.g.s., that is to say 17.68 times lower than that of the soil considered above, we find the same densities at depths which are  $\sqrt{17.68} = 4.2$  times less. Thus for uniform sinusoidal currents of frequency  $10^7/2\pi$  the density is reduced to 0.04 of its surface value at a depth of 2.80 m. For copper the depths at which similar current densities occur are  $44 \times 10^6$  times less than those given in the table, while for iron, in which the permeability is an added hindrance to penetration, there is a still further reduction—currents of frequency  $10^7/2\pi$  penetrating only about 1/100 mm. In general the resistance of the useful upper layer of the conductor is proportional to the resistivity. Thus for any given current the Joulean waste of energy is proportional to the resistivity of the conductor. The author then determines the thickness of the layer in which any definite fraction of the total current is to be found. Thus 95 per cent. of a sinusoidal current of frequency  $10^7/2\pi$  is found before reaching a depth of 6 m. in soil of resistivity  $66 \times 10^{11}$  c.g.s., while in salt water the depth is 1/4.2, for copper 1/44000, and in iron of permeability 8500, 1/10<sup>6</sup> of this. The resistance of a strip of definite width is (in spite of its infinite depth) a perfectly definite quantity which increases with the resistivity, with the frequency, with the permeability, and with the damping. *Application to Wireless Telegraphs.*—Experiments have shown (1) That transmission is better over sea than land; (2) that the range is greater, the lower the frequency and the less the damping. One of the theories proposed for the explanation of wireless telegraphy consists in an

adaptation of the modern theory of the propagation of electric currents in conductors. Thus, the waves propagated spherically in a dielectric, are concentrated in the neighbourhood of a conductor where they dissipate a part of their energy. On this hypothesis a wireless telegraph resembles a wire telegraph, in that the resistances of the conductor and of the receiver must be taken into account in order to determine the proportion of energy available at the latter. But the resistance of the useful strip of the earth's surface has been shown mathematically to depend on the resistivity, frequency and damping, and it is just on these that distance of transmission depends. The coincidence is strong evidence in support of the theory of transmission quoted above. The author then shows that the resistance between one point and another on the surface of a sphere does not depend on the distance, but only on the resistivity, frequency, and damping. Finally a description is given of the experiments by means of which the values quoted for the resistivities of soil and salt water were obtained.

J. E.-M.

**312. Temperature-variation of Ferromagnetism.** P. Weiss. (*Comptes Rendus*, 148. pp. 1186-1189, Dec. 24, 1906.)—Langevin has shown that the magnetism of feebly magnetic bodies can be explained by the static equilibrium resulting from the action of an exterior field on the molecules possessing magnetic moment and susceptible to thermic variation. In ferromagnetic substances the mutual actions between these molecules is an important factor in rendering possible the phenomenon of magnetic saturation. In this paper the author shows that a theory of ferromagnetism can be founded on an extremely simple hypothesis concerning these mutual actions. He supposes that each molecule exerts on the molecules surrounding it a force equal to that which it would exert if placed in a uniform field  $NI$  proportional to the intensity  $I$  of the excitation and in the same direction,  $NI$  is called the interior field. The further supposition is made that in ferromagnetic materials, just as in a gas, the kinetic energy of the molecules is opposed only to their orientation, so that Langevin's theory of magnetic gases applies. This gives  $I/I_0 = \frac{\cosh \alpha}{\sinh \alpha} - \frac{1}{\alpha} \dots (1)$ , where  $\alpha = \mu H / \tau T$ ;  $\mu$  is the magnetic moment of a molecule,  $\tau T$  twice the energy corresponding to one degree of freedom of a molecule,  $H$  the field,  $I$  the intensity of magnetisation, and  $I_0$  its maximum value. If there is no exterior field  $H = NI$  and  $\alpha = \mu NI / \tau T \dots (2)$ . Equation (1) gives a curve which cuts the straight-line graph of the last equation at a point whose ordinate measures the intensity of excitation at saturation at the temperature  $T$ . When  $T$  is sufficiently small, the point of intersection is real. It ceases to be so for a certain temperature  $\theta$ , which is the temperature at which ferromagnetism vanishes. The equation (2) can be put in the form  $T/\theta = (3/\alpha) I/I_0 \dots (3)$ , and equations (1) and (3) express the relation between the intensity of excitation and the temperature by means of the auxiliary variable  $\alpha$ . Experiments were made to verify this law, with satisfactory results. (*Ibid.* 144. pp. 25-28, Jan. 7, 1907.)—A continuation of the theory, but for temperatures above that at which iron loses its magnetism. Let  $\alpha$  denote the condition of iron up to this temperature ( $\alpha = 758^\circ \text{C.}$ ). Above this temperature the ratio  $\chi$  of the susceptibility to the density  $D$  decreases from an infinite value according to a hyperbolic law. Let  $\beta$  denote this stage. After the transition stage from  $820^\circ$  to  $920^\circ$ , the susceptibility varies from  $920^\circ$  to  $1,280^\circ$  in inverse ratio to the absolute temperature  $T$ . Let  $\gamma$  denote this stage. At  $1,280^\circ$  the susceptibility suddenly increases in the ratio 3 : 2 and seems again to vary inversely as  $T$ . Call



this stage  $\delta$ . For paramagnetic bodies the product  $\chi T$  gives Curie's constant  $C$ . It is shown in this paper that each of the four regions  $\alpha$ ,  $\beta$ ,  $\gamma$ ,  $\delta$  gives a determination of this constant. Langevin's theory gives for paramagnetic gases the formula  $\chi = (I_0^2/3\mu_0 D) M_0/M$ , where  $M$  is the number of molecules per c.c.m. and  $M_0$  the number at the same temperature and normal pressure  $p_0$ . For solid bodies, let  $n$  be the number of atoms in the molecule of the body,  $a$  its atomic weight,  $\delta$  the density of air; then  $C = \chi T = (I_0^2/D)(273/3p_0)na\delta/28.8$ . This gives  $C = 0.001646 \times n$ . Curie's results give for the  $\beta$  stage  $C = 0.00184 \times 2$ , and for the  $\gamma$  stage  $C = 0.00172 \times 2$  and  $0.00182 \times 2$ ; so that, to the degree of precision of the experiments, there is a good agreement if in the first three stages the molecule of iron is regarded as being composed of two atoms. For the  $\delta$  stage,  $C$  is found to have values  $0.00198 \times 3$  and  $0.00178 \times 3$ , which agree with the former results if in this stage the molecule is composed of three atoms. A. W.

313. *Irreversibility of the Heusler Alloys.* B. V. Hill. (Phys. Rev. 23. pp. 498-503, Dec., 1906.)—The author's further experiments confirm his previous conclusions [see Abstract No. 2274 (1905)]. In a general way the permeability of the alloys upon return to atmospheric temperature decreases as the max. temperature reached increases, up to a certain point, and then increases again with still higher annealing temperatures. For example, an alloy of Cu 68 per cent., Al 34.3, and Mn 2.7 per cent., as cast, in a field of 88 c.g.s. in each case, gave an intensity of 41. After heating to  $325^\circ$ , it gave an intensity of 41 at atmospheric temperature; after heating to  $490^\circ$  the intensity was 14, and after heating to  $810^\circ$  it was 63 c.g.s. units. The temperature-intensity cycles are irreversible, but cannot be repeated as with irreversible nickel steels, partly on account of time-lag of changes at any particular temperature. F. R.

314. *Magnetograph Records of Earthquakes, with Special Reference to the San Francisco Earthquake of April 18, 1906.* L. A. Bauer. (Terrestrial Magnetism, 11. pp. 135-144, Sept., 1906. Summary of two addresses, delivered one before the Geolog. Soc. of Washington, the other before the Amer. Assoc. for Advancement of Science.)—In recent years earthquakes have repeatedly been recorded by the magnetographs of the United States, while the Milne and the Bosch-Omori seismographs have not given records. On the other hand, the San Francisco earthquake did not affect the Porto Rico magnetograph, of the same pattern as others, at all, while it threw the seismograph pointer off the scale. Again, the seaquake west of Ecuador of Jan. 31, 1906, disturbed the seismograph at Honolulu, but not the magnetograph. Instruments of the one or the other class may, moreover, be disturbed at certain places, and not at others. Though the cause of the disturbance of the magnetograph seems, as a rule, and in the case of the San Francisco earthquake, to be mechanical, magnetic effects due to strain of the magnetic rocks or to their redistribution, are not impossible. The correlation of the two kinds of records had been investigated by Milne in 1898, and also by Eschenhagen, Wild, Liznar, and Messerschmidt, and is now studied by the Department of Terrestrial Magnetism of the Carnegie Institute, Washington, in co-operation with the Coast and Geodetic Survey and the Canadian Meteorological Service. A table concerning records obtained at observatories in different parts of the globe shows that the preliminary tremor of the San Francisco earthquake was recorded at Honolulu and Cheltenham (Maryland), which are about equally distant from San Francisco, at the same time; the magneto-

graphs indicated only the principal portion of the waves. The Baldwin Magnetic Observatory at Kansas records many of the local earthquakes of the middle States which fail to affect the seismographs at Washington; in some cases lightning discharges have produced the same effect as seismic disturbances. The author points out that, owing to their optical arrangement, magnetographs can only respond to a turning movement, to produce which the suspended bar must be a magnet. Yet the magnets of very small weight might also be regarded as pendulum seismographs.

H. B.

## ELECTRO-PHYSIOLOGY AND ELECTRO-THERAPEUTICS.

315. *Determination of Radiochromometric Intensity by Electrostatic Voltmeter in Röntgen Ray Work.* J. Bergonié. (Comptes Rendus, 144. pp. 28-29, Jan. 7, 1907.)—The author has previously dealt with the employment of a hot-wire voltmeter in shunt to the primary of the coil or transformer used, whose secondary supplies the tube (Archives d'Él. Médicale, p. 496, 1906). Since electrostatic voltmeters are, however, now made and graduated up to 60,000 volts, the author has made experiments with one of these by Hartmann and Braun, with magnetic damping, placed directly across the tube terminals. It is found that (1) whatever the current through the tube (0.1-1.0 milliamp.), if the voltmeter reading be maintained constant the rays emitted by the tube are always practically of the same radiochromometric value. (2) The higher the voltage the greater the radiochromometric value of the rays (*i.e.*, are more penetrating). Using a d'Arsonval-Gaiffe apparatus whose transformer is supplied by a special commutator, and a Benoist radiochromometer, the following values are obtained connecting the voltage with the radiochromometric value:—

| Voltmeter Reading. | Degrees of Radiochromometer. | Voltmeter Reading. | Degrees of Radiochromometer. |
|--------------------|------------------------------|--------------------|------------------------------|
| 12,000             | 2+                           | 80,000             | 5                            |
| 20,000             | 8                            | 85,000             | 6—                           |
| 25,000             | 4                            | 42,000             | 7                            |

Above 42,000 volts the tube gives uncertain results. (3) Using Röntgen-ray tubes of different shape in different stages of use and supplied with variable currents, the radiochromometric degree is found always to be the same at the same voltage. The volts and the milliamps. being accurately readable, the quantity of energy emitted should be capable of being deduced. Further investigations are being made on this point. [Compare Abstract No. 291 (1907).]

L. H. W.

316. *New Method of Dosage for Röntgen Rays.* J. Curchod. (Archives d'Él. Médicale, 15. pp. 29-31, Jan. 10, 1907. Paper read before the Assoc. Franç. pour l'Avancement des Sciences, at Lyons.)—The author considers the employment of Holzknacht's scale as being too risky, and hence puts forward a new method of estimating the quantity of Röntgen rays to which a patient has been exposed. The method depends on the use of the gas-voltmeter. The voltmeter is calibrated by exposing a Sabouraud pastille at 15 cm. distance from the tube antikathode, using only a low current so as to avoid

thermal effects on the pastille, and watching what level the water has reached when the pastille has attained the tint B. of the Sabouraud-Noiré chromo-radiometer. By noting the level when the exposure indicates 6.5 on the Benoist scale, the maximum dose allowable, it is always an easy matter to terminate the exposure at any other séance before this dose is exceeded.

L. H. W.

## REFERENCES.

317. *Mechanical Explanation of Electrical Phenomena.* H. Witte. (Deutsch. Phys. Gesell., Verh. 8. 20. pp. 497-510, Oct. 30, 1906. Paper read before the 78 Naturforscherversamml., Stuttgart, Sept. 20, 1906.)—This address takes a survey of the conceivable mechanical theories of electrical phenomena and then proceeds to discuss them and rule out some as being intractable.

E. H. B.

318. *Current Stream-lines.* W. Holtz. (Ann. d. Physik, 21. 2. pp. 390-392, Nov. 8, 1906.)—The appearance when finely broken-up gold-leaf is suspended in water [see Abstract No. 1599 (1906)] and in alcohol is described. The appearance is not quite the same in water as in alcohol, and differs at the anode and kathode.

S. G. S.

319. *Equalisers of Potential.* M. Moulin. (Comptes Rendus, 143. pp. 884-887, Dec. 3, 1906. Annal. Chim. Phys., 10. pp. 40-98, Jan., 1907.)—Deals with the possible errors of the various equalisers of potential used in meteorology and how they may be obviated. It is contended that only the water-dropper is rigorous, but that the salts of radium act well if certain specified conditions are observed. Flames and matches are also discussed.

E. H. B.

320. *Use of Wehnelt Interrupter with Righi Exciter for Electric Waves.* A. D. Cole. (Phys. Rev. 23. pp. 238-244, Sept., 1906. Electrician, 58. pp. 21-23, Oct. 19, 1906.)—Description of apparatus suitable for demonstrating Hertz's experiments before a large audience.

321. *Mechanically-produced Conductivity of a Coherer.* R. Thöldte. (Ann. d. Physik, 21. 1. pp. 155-169, Oct. 25, 1906. Écl. Electr. 49. pp. 435-436, Dec. 15, 1906.)—Employing a coherer consisting of two crossed rods of aluminium just touching one another, the author examined the difference between the conductivity produced by electrical and that produced by mechanical means (tapping, &c.). In all cases the p.d. applied was below the critical value. The results lead to no very definite conclusion.

L. H. W.

322. *Operation of Spark-coil with Continuously-acting Interrupter.* W. B. v. Czudnochowski. (Deutsch. Phys. Gesell., Verh. 8. 28. pp. 680-684, Dec. 15, 1906.)—A simple method of connection is described which obviates the necessity of using an auxiliary battery for working the interrupter.

L. H. W.

323. *Kelvin Double Bridge.* A. E. Moore. (Elect. Engin. 38. pp. 916-917, Dec. 28, 1906.)—Contains some notes on a graphical proof of the rule for comparing resistances by this method.

F. E. S.

324. *Glass of Low Resistivity.* C. E. S. Phillips. (Electrician, 57. p. 707, Aug. 17, 1906. Paper read before the British Assoc. at York, Aug. 7, 1906.)—States the proportions for a mixture which gives a glass of resistivity of order  $10^8$  ohms per c.cm. at  $20^\circ \text{C}$ .

325. *Picou Permeameter.* A. Campbell. (Electrician, 58. pp. 123-125, Nov. 9, 1906.) [See Abstract No. 831 (1906).]

## CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

**326. Distillation of Alloys of Silver with Copper, Tin, and Lead.** H. Moissan and T. Watanabe. (*Comptes Rendus*, 144, pp. 16-19, Jan. 7, 1907. *Ind. Élect.* 16, pp. 43-44, Jan. 25, 1907.)—Employing the electric furnace and condensing apparatus previously described [see Abstract No. 401 (1906)], and a current of about 5 amps. at 110 volts, the authors have distilled alloys of silver with copper, tin, and lead. They conclude that lead is more volatile than silver, and silver than copper or tin. W. H. St.

**327. Preparation of Pure Helium by Filtering the Gases from Cleveite through a Wall of Silica.** A. Jaquerod and F. L. Perrot. (*Comptes Rendus*, 144, pp. 185-186, Jan. 21, 1907.)—Helium diffuses readily through the walls of a silica-flask heated to a high temperature, while other gases, with the exception of hydrogen and perhaps carbon monoxide, do not penetrate even at a temperature of  $1,067^{\circ}$ . These facts form the basis of an easy method of obtaining pure helium; hydrogen and carbon monoxide may be easily eliminated, as water and carbon dioxide respectively, by adding to the original mixture of gases before diffusion a sufficient proportion of oxygen. D. H. J.

**328. Making Quartz Glass free from Bubbles.** (D.R.-P. 175,885. *Zeitschr. Elektrochem.* 13, p. 8, Jan. 4, 1907. Abstract.)—According to W. C. Heraeus, when small pieces of quartz or intentionally cracked quartz are fused together, the resulting quartz vessels will always be turbid with air bubbles. When, however, the quartz is gradually heated up to  $600^{\circ}\text{C}$ , and then suddenly, without cooling, brought up to the highest temperature, produced with the aid of the oxy-hydrogen flame, or of an iridium or carbon furnace, or by dropping the lumps of quartz into already fused quartz, a clear glass is obtained. The reason is that quartz gradually heated up to  $600^{\circ}$  no longer inclines to cracking. H. B.

**329. Sodium Peroxide for the Regeneration of Air in Submarine Boats.** G. F. Brindley and R. v. Foregger. (*Amer. Electrochem. Soc., Trans.* 9, pp. 291-301; Discussion, pp. 302-304, 1906.)—The electrolytically prepared, fused sodium peroxide or oxone of the authors, forms a hard mass of density 2.48, which can be cast, and which, in contact with water, slowly evolves pure oxygen while caustic soda is formed. The soda absorbs the  $\text{CO}_2$  and coats the peroxide with a crust of carbonate; the oxygen evolution would thus be stopped unless the crust is removed, which is, for practical purposes, best done by placing the peroxide in a wire-netting cylinder which is agitated. Experiments made in a box with rabbits and men show that 1925 gm. of oxone really give the required 25 litres of oxygen which a man requires per hour, and that 9 kg. of oxone should sustain nine men in a submarine boat of 2,700 cub. ft. capacity for 9 hours before the  $\text{CO}_2$  percentage would rise above 0.9; the box of the authors had a capacity of 54 cub. ft., being  $3 \times 3 \times 6$  ft. In the discussion, which took place in the absence of the authors, by Ashcroft, Bancroft, Carrier, Dennis, S. S. Sadtler, and H. Howard, it was suggested that oxone contains some catalytic agent to moderate the otherwise violent reaction with water. H. B.

**330. Chemical and Electrical Changes induced by Ultra-violet Light.** **W Ramsay and J. F. Spencer.** (Phil. Mag. 12. pp. 897-418, Oct., 1906. Electrician, 58. pp. 877-878, Dec. 21, 1906. Abstract. Écl. Électr. 50. pp. 91-92, Jan. 19, 1907.)—The authors lay down the hypothesis that positive ions are atoms of elements which have lost one or more electrons, and negative ions those which have gained such electrons, and experiments are described which are in agreement with this hypothesis. Electrons appear capable of associating themselves with matter in three ways: (1) as a surface-film when removed by friction their absence is termed "positive electrification"; (2) in a condition analogous to that of one element in a chemical compound—an ion of chlorine, for example, being "chlorine-stuff" plus an electron, common salt a compound of "sodium-stuff" with "chlorine-stuff" and an electron, and a positive ion an elementary "stuff" unassociated with an electron or with any other kind of atom; (3) associated with one kind of matter to form another kind of matter, so that if the electron be lost without leaving a positive ion with the matter, the latter will be transmuted into atoms of lower atomic weight, or possibly several such residues may associate to form an atom of higher molecular weight. Many metals lose their electrons under the influence of ultra-violet light, and, with a large number of metals examined, it was found that the rates of emission of electrons—that is, the rates of discharge of the element—are, as a rule, in the same order as their electro-potentials. Of the few exceptions it is noteworthy that they readily assume the passive condition. Experiments with certain sulphides and iodides indicate that corpuscles are emitted also from compounds. Other phenomena, such as the e.m.f. of cells in which one element is exposed to light, the firing of metals when exposed to ultra-violet light, &c., were also investigated. T. H. P.

**331. Law for Capillary Phenomena analogous with that of Trouton for Latent Heat of Evaporation.** **W. Kistiakowsky.** (Zeitschr. Elektrochem. 12. pp. 518-514, July 27, 1906.)—If  $a$  represents Poisson's capillary constant for a liquid at its boiling-point  $T$ , and  $M$  its molecular weight, the author shows that the value of  $aM/T$  is constant ( $K'$ ). With 90 non-associated liquids examined, the value of  $K'$  varies from 0.0101 to 0.0119, the mean being 0.0116. For associated liquids the values of  $K'$  differ from this number. Water and acetic acid, for example, only give the value 0.0116 if a double molecular weight is ascribed to them. The above expression may hence be employed to determine the molecular weights of liquids. T. H. P.

**332. Absorption of Nitrogen and Hydrogen by Aqueous Solutions.** **G. Hufner.** (Zeitschr. Phys. Chem. 57. pp. 611-625, Jan. 8, 1907.)—The author investigated the absorption of nitrogen and hydrogen in solutions of varying concentrations of grape sugar,  $\alpha$ -amido-propionic acid, glycol, erythrite, urea, and acetamide. The results obtained show that the lowering of the coefficient of absorption for the two gases in water, by the addition of the solid substances, is determined by the weight of substance in solution and not by the number of molecules. F. J. B.

**333. Surface Tension of Aqueous Solutions.** **Géza Zemplén.** (Ann. d. Physik, 20. 4. pp. 783-797, July 20, 1906. Extract from Dissertation, Budapest, 1904. From the Hungarian.)—With a view to extending the principle of Eötvös from simple homogeneous liquids to solutions, the surface tensions



of aqueous solutions of silver nitrate, urea, and common salt, have been determined at different temperatures by the Eötvös method. The results show that the principle is applicable to aqueous solutions with the same exactness as to homogeneous liquids. In the case of electrolytes the concordance between theory and experiment is best when the electrolytic dissociation is taken into account in calculating the temperature-coefficients. The results are opposed to the view that a change in the degree of association of the water molecules occurs on forming an aqueous solution.

D. H. J.

**334. Diffusion in Jelly.** H. Bechhold and J. Ziegler. (*Zeitschr. Phys. Chem.* 56, pp. 105-121, July 17, 1906.)—From physiological investigations the authors assume that the permeability of a colloidal medium is influenced by the diffusing substance and also by any other substances present. The permeability of gelatine and agar jellies for various electrolytes and non-electrolytes is determined, using a colouring matter to indicate the path of diffusion. In other cases the latter is rendered evident by previously adding to the jelly a small quantity of a compound giving a precipitate with the diffusing substance. It is found that gelatine and agar jellies diminish the path of diffusion of electrolytes and non-electrolytes. The permeability of these jellies towards colouring matters is influenced very slightly by sodium chloride or iodide, but is considerably diminished by sodium sulphate, dextrose, glycerol, or alcohol. The diffusion of electrolytes is diminished by dextrose, glycerol, and alcohol, but increased by urea. No relation is evident between change of melting-point and change of diffusion in agar and gelatine jellies.

T. H. P.

**335. Atomic Weight of Silver.** P. A. Guye and G. Ter-Gazarian. (*Comptes Rendus*, 143, pp. 411-418, Sept. 10, 1906.)—On the bases of atomic weights of carbon, hydrogen, nitrogen, and chlorine, determined directly from that of oxygen by various gravimetric and physico-chemical methods, the atomic weight of silver is 107.89. The number, 107.93, given by Stas, is shown by the authors to be erroneous owing to the fact that crystallised potassium chlorate always contains a small proportion of chloride. When a suitable correction is introduced, the results of Stas yield the value 107.898.

T. H. P.

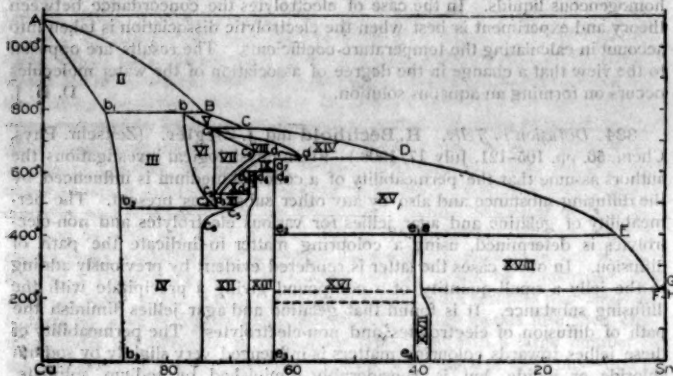
**336. Refractive Indices of Salts dissolved in Organic Liquids.** C. Chéneveau. (*Comptes Rendus*, 142, pp. 1520-1522, June 25, 1906.)—Determinations of the refractive indices are made for the following substances: LiCl, CaCl<sub>2</sub>, CuCl<sub>2</sub>, SnCl<sub>2</sub>, and MgCl<sub>2</sub>, dissolved in ethyl alcohol; LiCl in methyl alcohol; ZnCl<sub>2</sub> in ethyl ether, and NH<sub>4</sub>Cl in glycerine. For these salts the difference between the index of the solution and that of water (or the solvent), calculated from the concentration by means of the law of Gladstone or Lorentz, is sensibly proportional to the concentration, and the constant of proportionality differs little from that obtained for the aqueous solutions of the same substances.

G. E. A.

**337. New Silicide of Manganese.** G. Gin. (*Comptes Rendus*, 148, pp. 1229-1280, Dec. 31, 1906.)—By reduction of rhodonite in the electric furnace a silicide of manganese has been prepared corresponding to the formula Si<sub>2</sub>Mn<sub>3</sub>, which crystallises in long prisms having a density of 6.06 at 15° C., and melting between 1,250-1,300° C. P. Lebeau (*ibid.* 144, pp. 85-86, Jan. 14, 1907) doubts the existence of this new silicide, and considers the product described by Gin to be merely impure SiMn<sub>2</sub>.

W. H. St.

**338. Constitution of the Copper-Tin Alloys.** E. S. Shepherd and E. Blough. (Journ. Phys. Chem. 10, pp. 680-688, Nov., 1906.)—The authors arrive at the accompanying diagram for the Cu-Sn alloys. In order to



determine the compositions of the solid phases Bancroft's analytical method was adopted, lead being chosen as the third component.

Field I. -  $\alpha$

" II. -  $\alpha + \text{liquid}$

" III. -  $\alpha + \beta$

" IV. -  $\alpha + \delta$

" V. -  $\beta + \text{liquid}$

" VI. -  $\beta$

Field VII. -  $\beta + \gamma$

" VIII. -  $\gamma$

" IX. -  $\gamma + \text{Cu}_3\text{Sn}$

" X. -  $\gamma + \delta$

" XI. -  $\beta + \delta$

" XII. -  $\delta$

Field XIII. -  $\delta + \text{Cu}_3\text{Sn}$

" XIV. -  $\gamma + \text{liquid}$

" XV. -  $\text{Cu}_3\text{Sn} + \text{liquid}$

" XVI. -  $\text{Cu}_3\text{Sn} + \epsilon$

" XVII. -  $\epsilon$

" XVIII. -  $\epsilon + \text{liquid}$

The authors have not as yet succeeded in establishing the significance of the thermal changes at  $218^\circ$  and  $182^\circ$  in Field XVI., nor as to whether pure tin or a solid solution separates along FG. The complete paper is to be published later, with photographs of the characteristic structures corresponding to each region, and giving in greater detail the methods of investigation. [See also Abstract No. 1800 (1905).] F. R.

**339. Antimony-Cadmium Alloys.** W. Treitschke. (Zeitschr. Anorg. Chem. 50. 3, pp. 217-225, Aug. 31, 1906. Metallog. Communication from the Inst. f. anorg. Chemie d. Univ., Göttingen.)—Contains two complete temperature-concentration diagrams of the Cd-Sb series obtained by spontaneous crystallisation and by inoculation with powdered solid of the same composition respectively. Two chemical compounds are found in this series; one of these is absolutely stable and corresponds to the formula  $\text{SbCd}$ , while the other is unstable and probably has the formula  $\text{Sb}_2\text{Cd}_3$ . The latter compound and the series of solid solutions of which it forms a constituent separate spontaneously from all fusions containing from 80 to 100 per cent. Sb. The end member of this series of solid solutions, i.e., the saturated solid solution containing 58 per cent. Sb, is found in all the alloys from 100 to 58 per cent. Sb associated with primary crystals of Sb. From 50 to 8 per cent. Sb no spontaneous crystallisation of the compound  $\text{Sb}_2\text{Cd}_3$  was ever observed, the stable compound  $\text{SbCd}$  always crystallising out in characteristic long columns. By rapid cooling (quenching) it is, however,

possible to fix the compound  $Sb_2Cd_3$  even in alloys containing more than 42 per cent. Sb. Fusions containing from 100 to 42 per cent. Sb, if inoculated with solid powder of the same alloy which had been slowly cooled, always give characteristic columnar crystals of  $SbCd$ . The alloys from 100 to 42 per cent. Sb can be obtained in three forms: after inoculation, aggregates containing Sb and the compound  $SbCd$  are produced; by spontaneous crystallisation, followed by quenching at about  $400^\circ C.$ , a solid solution of Sb in the compound  $Sb_2Cd_3$ , or a mixture of this solution with excess of Sb, is obtained; while finally, by slow cooling after spontaneous crystallisation, a conglomerate of  $SbCd$  and Sb crystals results. W. Ros.

**340. Heat Treatment of Wire.** J. D. Brunton. (Iron and Steel Inst., Journ. 70, pp. 142-156, 1906. Carnegie Scholar's Report. Metallurgie, 8, pp. 788-789, Nov. 8, 1906. Abstract.)—Hot-rolled rods, one of 0.75 per cent. carbon, acid open-hearth Swedish steel, another of 0.88 per cent. carbon (a similar British steel), one portion of each being primarily annealed, were drawn down to wire, the tensile strength, elongation, number of twists required for destruction of a length equal to 100 diams., and specific gravity, being observed at each stage, and in the earlier stages chemical composition was also observed. After the first half-dozen passes the wires were also tested whilst suspended in tension over an oscillating pulley, the number of oscillations required to produce rupture being recorded. The first steel, unannealed, increased in sp. gr. from 7.768 to 7.998 in 16 passes, and then became lighter with further working. The tensile and torsion tests also indicate clearly at what stages overdrawing begins. The preliminary annealing was found to be without practical effect after the first few passes. Both carbon and phosphorus contents in the wire appeared less after annealing than before; this was verified by experiments on a number of other steels. F. R.

**341. Crystallography of Iron.** F. Osmond and G. Cartaud. (Iron and Steel Inst., Journ. 71, pp. 444-488; Correspondence, pp. 489-492, 1906. Amer. Inst. Mining Engineers, Bull. 12, pp. 989-1085, Nov., 1906. Joint Meeting Paper. Soc. d'Encouragement. Rev. de Metallurgie, Mém. 8, pp. 491-526, Dec. 1, 1906.)—The authors' results are summarised in the following table:—

|                                 | $\alpha$ -Iron.                                                              | $\beta$ -Iron.                                                             | $\gamma$ -Iron.                                                       |
|---------------------------------|------------------------------------------------------------------------------|----------------------------------------------------------------------------|-----------------------------------------------------------------------|
| Planes of translation .....     | $\left\{ \begin{array}{l} a^1 (111) \\ \text{Difficult} \end{array} \right.$ | None known                                                                 | $a^1 (111)$ Easy                                                      |
| Folds .....                     | Dominant                                                                     | Exclusive                                                                  | Absent                                                                |
| Mechanical twinning—            |                                                                              |                                                                            |                                                                       |
| Planes of twinning .....        | $a^1 (111)$                                                                  | $\left\{ \begin{array}{l} \text{None} \\ \text{known} \end{array} \right.$ | $\left\{ \begin{array}{l} a^1 (111) \\ a^1 (111) \end{array} \right.$ |
| Planes of junction .....        | $a^2 (112)$                                                                  |                                                                            |                                                                       |
| Twinning by annealing—          |                                                                              |                                                                            |                                                                       |
| Planes of twinning .....        | $\left\{ \begin{array}{l} \text{None} \\ \text{known} \end{array} \right.$   | $\left\{ \begin{array}{l} \text{None} \\ \text{known} \end{array} \right.$ | $\left\{ \begin{array}{l} a^1 (111) \\ a^1 (111) \end{array} \right.$ |
| Planes of junction .....        | $a^1 (111)$                                                                  | ?                                                                          | $a^1 (111)$                                                           |
| Face of maximum hardness .....  | $a^1 (111)$                                                                  | ?                                                                          | $b^1 (011)?$                                                          |
| Planes of easiest etching ..... | $p (001)$                                                                    | $p (001)$                                                                  | $p (001)$                                                             |

Planes of translation, twinning, cleavage, and segregation, may be planes of greatest reticular density. It is deduced that with  $\alpha$ -iron having simple cube mesh, and  $\gamma$ -iron a cube with centred faces, then  $\beta$ -iron would be a centred

cube. As on the other hand the number of intersections is equal to that of the cube meshes for the simple cube, double for the centred cube, and quadruple for the cube with centred faces, each allotropic modification of iron would be characterised by a division into halves of the molecular polyhedron with rising temperature. Neumann's lamellæ are attributed to the formation of  $\beta$ -iron under shock—a view which receives support from the laws of the appearance and disappearance of magnetism. Another course of argument may be followed by regarding mechanical twinning as a proof of mero-symmetry. It is pointed out that although the data are not yet enough to form a sound foundation for a complete hypothesis, yet it can positively be affirmed that the three allotropic modifications of iron all crystallise in the cubic system, but present well-marked characteristics, and cannot have the same internal structure. F. R.

**342. Hardening and Tempering of Steel.** F. Osmond, (Soc. d'Encouragement, Rev. de Métallurgie, Mém. 8, pp. 477-488, Dec. 1, 1906.)—Deals with the researches of Heyn [see Abstract No. 1488 (1906)], giving an abstract of the experimental results, and proceeds to draw theoretical conclusions from these and other data. The final view arrived at is that there are four possible factors in the hardening of steel, viz., (1) retention of carbon in the metastable condition of hardening carbon, (2) partial retention of an allotropic modification of iron which is also metastable at ordinary temperatures, and (3) hardening by over-strain (ecrouissage) in consequence of the change of volume which accompanies the partial transformations. While each of these factors has been separately stated previously, the author now claims to be able, for the first time, to state exactly the part played by each. Heyn's experiments he regards as proving for the first time directly that the effect of carbon on the properties of hardened steel is practically nil, since the hardness produced by quenching has lost more than 70 per cent. of its intensity after tempering below  $400^{\circ}\text{C}$ . (the remaining hardness being due to strain), while hardening carbon is not transformed into cementite until tempering has been carried to  $400^{\circ}$ – $600^{\circ}\text{C}$ . Further, hardened steel gives off the greater part of its heat during tempering below  $400^{\circ}\text{C}$ ., and this evolution of heat can no longer be attributed to any cause but the return of the allotropic iron to the  $\alpha$  condition; and this allotropic iron is thus, in the author's opinion, the sole possible cause of the properties of positively quenched steels. The author finally gives the following definitions of the constituents of steel: Martensite is a mixture of  $\alpha$ -iron in a strain-hardened condition with allotropic iron, containing also some hardening carbon. Troostite is a transition form in which the amount of allotropic iron passes from its maximum to a low or even zero value; the remainder of the iron is in the strain-hardened  $\alpha$  condition, while the carbon remains in the form of hardening carbon. Osmondite consists essentially of strain-hardened  $\alpha$ -iron with the carbon in the hardening condition. Sorbite is a transition form in which the carbon passes from the hardening to the cementite form, and the iron passes from the strain-hardened  $\alpha$  condition to the crystallised  $\alpha$  state, with a separation (liquation) of the two constituents, while finally pearlite is a mixture of cementite and crystallised  $\alpha$ -iron. W. Ros.

**343. Etching of Iron and Mild Steel for Investigation of Macrostructure.** E. Heyn. (Königl. Materialprüfungsamt, Mitt. 24. 5, pp. 258-268, 1906. Paper read before the International Assoc. for Testing Materials, Brussels, 1906.)—The method of etching found most suitable is immersion of the

polished sample for 1 min. in 1 in 12 solution of cuprammonium chloride, the loose deposited copper being removed by cotton-wool. The method is unsuitable for graphitic cast iron, but is generally preferable to hydrochloric acid. Characteristic dark spots, patches or bands, develop where there is segregation of C or P, or in cold-worked areas. The markings obtained by etching are correlated with segregation, primary crystallisation in the ingot, and effect of forging, with chemical analyses and mechanical properties, in numerous instances. Welds and fractures can readily be studied by the same means. Segregated sulphur is detected upon covering the sample with silk cloth and treating with  $\text{HgCl}_2$ , when the silk is blackened in portions over the high-sulphur areas. F. R.

**344. Copper-Nickel Alloys.** W. Guertler and G. Tamman. (Zeitschr. Anorg. Chem. 52. 1. pp. 25-29, Jan. 8, 1907. Communication from the Inst. f. anorg. Chem. d. Univ., Göttingen.)—The equilibrium diagram of these alloys, as determined by the authors, shows a continuous liquidus and a range of solidification which indicate the formation of a continuous series of solid solutions between the two metals; the authors' curve, however, differs considerably from that obtained by Gantier, who found a distinct break in the curve of freezing-points. The diagram of the present paper also shows a curve indicating the commencement of the magnetic change, which occurs in pure Ni at  $820^\circ \text{C}$ , and falls to  $80^\circ \text{C}$ . at 60 atomic per cent. Ni, but the method used by the authors did not enable them to determine the end of this transformation. The microstructure of the alloys is described and illustrated in the paper, and agrees completely with the equilibrium diagram as given by the authors. W. Ros.

**345. Influence of Chromium on the Solubility of Carbon in Iron.** P. Goerens and A. Stadeler. (Metallurgie, 4. pp. 18-24, Jan. 8, 1907. Communication from the eisenhüttenmänn. Inst. d. kgl. techn. Hochschule, Aachen.)—The authors find that the solidification temperature of iron saturated with carbon remains practically constant at about  $1,180^\circ \text{C}$ . upon addition of Cr up to about 10.4 per cent. Beyond this amount, however, it rises rapidly, reaching  $1,535^\circ$  with 62 per cent. Cr. The percentage of C required for saturation gradually increases from about 4 with no Cr to 9.2 with 62 per cent. Cr. The change at  $710^\circ \text{C}$ . is not altered in position, but its duration is diminished with addition of Cr until with 29.6 per cent. Cr (6.4 per cent. C.) and upwards it is absent. The results are plotted as a portion of the triangular diagram for the ternary system Fe—C—Cr, the curve being the projection of the eutectic line. F. R.

**346. A Case of Malleability of Grey Cast Iron.** (Metallurgie, 8. pp. 786-787, Dec. 8, 1906. Communication from the eisenhüttenmänn. Inst. d. kgl. techn. Hochschule, Aachen.)—A piece of cast iron of the following percentage composition was malleable at a red heat: Total carbon 3.21, graphite 2.34, carbide carbon 0.68, hardening carbon 0.19, Si 0.80. After forging a cylinder 86 mm. high and 60 mm. diam. down to 15 mm. high, the composition was: Total carbon 2.69, graphite 1.98, carbide carbon 0.68, hardening carbon 0.28, Si 0.80. It is found that the most favourable condition of the material occurs when the graphite amounts to about 70 per cent. of the total carbon, as then the continuity of the metal is not too much destroyed, as with higher proportion of graphite, nor is the metal too hard, as with lower graphite. F. R.



**347. Solubility of Carbon in Manganese Protosulphide.** M. Houdard, (*Comptes Rendus*, 143. pp. 1280-1283, Dec. 31, 1906.)—Manganese protosulphide, fused in the electric furnace, readily dissolves carbon, up to a maximum of 8.2 per cent. The graphite obtained therefrom has an ignition temperature of about  $840^{\circ}\text{C}$ ., and on treatment with Brodie's mixture yields a pale yellow crystalline oxide, which on burning gives black pyrographitic acid. A diamond weighing 0.0608 gm. plunged in a mass of the fused sulphide was almost entirely converted into graphite, the residue obtained on extraction with dilute acid containing 0.0615 gm. graphite and a transparent particle weighing 0.009 gm. W. H. St.

**348. Osmotic Pressure in Colloidal Ferric Chloride.** G. Malfitano, (*Comptes Rendus*, 142. pp. 1418-1421, June 18, 1906.)—Duclaux [see Abstract No. 1954 (1905)] ascribes true osmotic pressure to colloidal solutions, but according to the author the phenomenon is quite different in nature from that observed with ordinary solutions. The pressure, or rather the force of expansion manifested by concentrated colloidal ferric chloride solutions, separated by a semi-permeable membrane from the solvent, does not appear to depend upon the mobility of the colloidal particles. Further, this force of expansion is limited and depends on the amount of electrolyte retained by the colloid and existing free in the solution. The particles remain uniformly distributed in the liquid owing to their mutual repulsion and attraction caused by the hydrogen and chlorine ions associated with them. T. H. P.

**349. Origin of Osmotic Effects.** H. E. Armstrong, (*Roy. Soc., Proc. Ser. A*, 78. pp. 264-271, Nov. 5, 1906.)—The comparative study of the action of enzymes and acids as hydrolysts has led to an explanation based on an association hypothesis. It is suggested that osmotic pressure and the related phenomena of elevation of boiling-point and depression of freezing-point depend in a similar way on the association of the solvent; for instance, in the case of water, on the reversible action  $(\text{H}_2\text{O})_n = n\text{H}_2\text{O}$ . It is suggested that the addition of a solute tends to break up the complex molecules into the simple monads represented by the formula  $\text{H}_2\text{O}$ , and that the flow of liquid from the solvent to the solution is caused by and is proportional to this dissociation. In comparing different solutions it is better to consider those in which equal weights of solvent are used to dissolve each gm.-molecule of solute, rather than those in which the molecular concentration is the same in equal volumes; as Morse and Frazer have shown, this leads to a close proportionality between osmotic pressure and concentration in sugar solutions from N/10 to 1.27 N. In order to account for the large osmotic effects produced by electrolytes such as potassium and calcium chlorides, it is suggested that the molecule as a whole acts normally, and that each atom of chlorine produces an additional effect which may vary from zero to that normally produced by a molecule. T. M. L.

**350. Course of the p.t. Curves for Constant Concentration for Equilibrium Solid Fluid.** A. Smits, (*Konink. Akad. Wetensch. Amsterdam, Versl.* 14. pp. 866-877, May 9, 1906. *Proc.*, 9. pp. 9-19, June 21, 1906.)—Van der Waals has discussed a special case [*Proc.*, 6. p. 171]. Starting from the general equation (Cont. ii. 112) if  $x = \text{const.}$ ,  $T(dp/dT)_x = W_v/V_v$  is obtained, and from this, on multiplying by  $d^2\psi/dv^2$ , the course of the p.t. lines. The general case when  $V_v < V_c$  is then developed, with diagrams. H. H. F. H.

**351. Organic Solvents and Ionising Media. IV. Ebullioscopic Measurements. V. Solvent Properties. P. Walden.** (Zeitschr. Phys. Chem. 55. pp. 281-302, April 18, and pp. 688-720, June 26, 1906.)—IV. The molecular elevation of the boiling-point was calculated from the latent heat of evaporation by van't Hoff's formula in the case of 17 organic solvents, and was also determined experimentally from observations on the "normal" electrolyte  $N(C_2H_5)_4I$  of the earlier papers. In every case the observed constant was less than the calculated value, the average difference being 8 per cent. The coefficients of ionisation deduced from the ebullioscopic measurements vary in the same way as those determined electrically, but are not, as a rule, identical. In the case of the alcohols the osmotic values are smaller than the electrical values, and the discrepancy increases with the concentration and with the molecular weight of the alcohol; the deviation of the osmotic values is attributed to association of the solute, which takes place only to a slight extent when the solvent has marked associating properties or is present in large amounts. V. The solubility was determined at 0° and 25° C. of tetraethylammonium iodide and a number of related compounds in a series of some 28 different organic liquids. [See Abstract No. 1327 (1906).]

T. M. L.

**352. Critical Solution-point of Ternary Mixtures. J. Timmermans.** (Zeitschr. Elektrochem. 12. pp. 644-647, Aug. 17, 1906. Paper read before the 18th Hauptversamml. der Deutsch. Bunsen-Gesell., May 22, in Dresden.)—On adding a third component to two liquids which become miscible when the temperature is raised, the critical temperature is raised if the third component only dissolves in one of the two liquids. The effect is approximately proportional to the molecular concentration of the third component, and there is thus an approximately constant "molecular elevation" of exceptionally large magnitude. If the third substance is moderately soluble in both liquids the critical temperature is usually lowered.

T. M. L.

**353. Decomposition of Ammonia and Formation of Ozone by the Silent Electric Discharge. R. Pohl.** (Ann. d. Physik, 21. 5. pp. 879-900, Dec. 14, 1906. Phys. Inst. d. Univ., Berlin, July, 1906.)—In the decomposition of ammonia or in the formation of ozone by the silent electric discharge, Faraday's law is not valid. The requisite amounts of electricity are less than those required by the electrolytic law, and the extent of the decomposition or formation varies greatly with the conditions of experiment. The energy consumed in the chemical action of the silent discharge also varies considerably. Thus the amount of ammonia decomposed per h.p.-hour varies from 1.8 to 2.5 gm., and in the case of ozone formation, from 21 to 46 gm. The maximum is found with low potential, high pressure, large surface, &c. No certain theoretical explanation of the processes occurring in the chemical action of the silent electric discharge can yet be given. [See also Abstract No. 625 (1906).]

A. F.

**354. Solubility and Oxidation-Potential of Plumbic Sulphate and Oxide. F. Dolezalek and K. Finckh.** (Zeitschr. Anorg. Chem. 51. 3. pp. 820-827, Dec. 8, 1906. Inst. f. physikal. Chemie, Göttingen.)—The solubility of lead persulphate in sulphuric acid is practically zero in an acid containing 948 gm.  $H_2SO_4$  per litre, but increases to 40 millimols. per litre at 22°, when the concentration of the acid is increased to 1,852 gm.  $H_2SO_4$  per litre. Soon after

this the solubility falls to a minimum at about 28 millimols per litre, but increases to 88.2 millimols when the acid concentration is 1,708 gm. per litre ( $2.18\text{H}_2\text{SO}_4 : 1\text{H}_2\text{O}$ ). The solubility of lead peroxide was determined, and values were also calculated from the observed solubility of the persulphate; a good agreement was observed in the range of concentrations below that at which the max. solubility of the persulphate was observed. The oxidation-potential for the persulphate is about 1.87 volts at  $11.5^\circ$ , but decreases slightly as the strength of the acid increases or decreases from the concentration  $0.57\text{H}_2\text{SO}_4 : \text{H}_2\text{O}$ . The acid concentration at which the oxidising action of the persulphate is a maximum varies with the temperature and is given by the formula  $\text{H}_2\text{SO}_4/\text{H}_2\text{O} = 0.55 + 0.0019t$ . T. M. L.

**355. Electrolyte Density in Storage Batteries.** L. Lyndon. (Amer. Electrochem. Soc., Trans. 9, pp. 67-75, 1906. Electrochem. Ind., N.Y. 4, pp. 214-215, June, 1906. Centralblatt Accumulatoren, 7, p. 179, July 5, 1906. Abstract.)—The author made experiments to determine the correctness of the theory that at the end of discharge there exist two separate bodies of electrolyte; one, greatly diluted, in the pores of the plates, and another which has undergone but slight change. If these two could diffuse and mix thoroughly, the density of the resulting mixture should be the same for a given amp.-hour discharge, and independent of the rate of discharge. In the experiments a given cell was discharged at various rates, and was then allowed to stand discharged for several hours. The density of the electrolyte is found to fall gradually, and in every instance reaches a value very near to the calculated value; the time of standing necessary for a constant value for the density to be reached being less with Planté-formed than with pasted plates. A modified formula is given for computing the quantity of electrolyte required, as being simpler than Fitzgerald's; this is—

$$x = S(0.129 - 0.1053d)/(D - d)$$

[decimal given in wrong place in original], where  $x$  = quantity of electrolyte, in ounces (avoir.);  $S$  = amp.-hours discharge;  $D$  = per cent. of  $\text{H}_2\text{SO}_4$  (initial);  $d$  = weight of  $\text{H}_2\text{SO}_4$  (final). The author is an advocate of high-density electrolyte, but the actual value depends upon the type of cell and other considerations. L. H. W.

**356. Electrolysis of Fused Zinc Chloride in Cells Heated Externally.** J. L. F. Vogel. (Faraday Soc., Trans. 2, pp. 56-68; Discussion, pp. 68-71, Aug., 1906.)—An investigation of a process, patented by Maxwell Lyte, in which zinc is obtained from its ores by conversion into anhydrous zinc chloride and electrolysis of the fused salt. Zinc chloride was prepared by treating the oxide with  $\text{HCl}$ , and the solution siphoned off, concentrated, and finally dehydrated by evaporation under a suction of about 20 mm. of mercury. The anhydrous salt was then electrolysed in a fireproof stoneware cell, the best form of which consists of a shallow vessel with the upper edge set back and turned up to form a seating for the carbons. Connection for the current was made by copper rods, dipping into pockets in the tops of the carbons, which were filled with solder and connected to a trough of solder. A heavy block of carbon at one end served as kathode, and a narrow strip of stoneware provided holes for feeding and for the exit of the chlorine. A run of  $10\frac{1}{2}$  days and nights at about 600 amps. produced over 8 cwt. of zinc at a current efficiency of  $91\frac{1}{2}$  per cent., the voltage across the terminals being between 4.0 and 5.0 volts. This trial led to the conclusions: (1) That the

proper material for the cell is a vitreous stoneware, capable of standing a temperature of  $500^{\circ}\text{C}$ .; (2) that gas-firing is preferable and more economical; (3) that a cover with as few joints as possible is necessary to prevent leakage either of chlorine from the cell or of air into it; (4) that carbons should be shaped in a way which would leave as little waste as possible when corroded too much for further use; and (5) that the level of the zinc should be constant to avoid variation in the voltage. Arrangements were made to carry out an experiment in accordance with these deductions, but the failure of one of the firms interested led to the matter being abandoned. Experiments by the United Alkali Co. with cells heated internally by the current, though technically successful, did not offer any prospect of commercial utility, and the author is convinced that an externally-heated cell has considerable advantages over an internally-heated one, there being less risk of volatilisation of  $\text{ZnCl}_2$ , and the cost being less. W. H. St.

**357. Electrolytic Deposition of Zinc, using Rotating Electrodes.** T. S. Price and G. H. B. Judge. (Faraday Soc., Trans. 2, pp. 85-90, Dec., 1906. Electrician, 57, pp. 453-454, July 6, 1906. Chem. News, 94, pp. 18-20, July 18, 1906.)—Zinc may be estimated electrolytically in zinc sulphate solutions, using a rotating cathode and keeping the electrolyte cool by surrounding it with a jacket containing ice. The apparatus employed by the authors consists of a tap-funnel of about 100 c.cm. capacity, into which the anode ring just fits, and in which is placed 50-60 c.cm. of the electrolyte, corresponding to 0.2-0.3 gm. of Zn. The Pt electrodes were of the form recommended by Perkin [Abstract No. 8187 (1904)], the cathode being rotated. The best results are obtained by starting with a current of 0.25 amp., raising it after 5 min. to 0.5 amp., and after another 5 min. to 1 amp. It then gradually increases in about 10 min. to 2 amps., at which it is kept for 20 min., the split cover-glass, which is placed over the mouth of the funnel, and the sides of the funnel being washed down about 5 min. before the end of the experiment. Addition of sodium sulphate alone, or with sodium acetate, to the zinc sulphate solution gives very good results, but the presence of sodium acetate alone renders the deposit of bad colour and liable to be spongy. The presence of free sulphuric acid to start with is objectionable. A modification of Kollock and Smith's apparatus [Abstract No. 486 (1906)] is also described, in which a rotating anode and a mercury cathode are employed. Instead of drying and weighing the Hg and Zn amalgam together in a glass tube, the Hg is first weighed in a porcelain crucible, placed in the electrolysis tube, and at the end of the experiment the amalgam run off through the tap of the funnel into the crucible. In this case the amount of free  $\text{H}_2\text{SO}_4$  should not exceed 2 drops of concentrated acid in presence of 0.2-0.35 gm. of zinc. W. H. St.

**358. Copper Kathodes in Nitric Acid.** J. W. Turrentine. (Journ. Phys. Chem. 10, pp. 715-720, Dec., 1906.)—The difference in behaviour between nitric acid acting upon copper and the reduction of nitric acid, electrolytically, using copper kathodes, was investigated. It is shown that: (1) When copper dissolves in nitric acid the anode reaction is the formation of copper nitrate and not copper nitrite. (2) The kathode reaction, on the other hand, is the reduction of nitric acid, the chief reduction-product being nitric oxide when the solution contains copper ions, and ammonia when the solution is free from copper ions. (3) When a mixture of nitric acid and copper nitrate is electrolysed, with a copper kathode, nitric oxide is formed at the kathode. (4) Electrolysis of nitric acid alone with a copper kathode yields ammonia

as the reduction product of nitric acid at the cathode. (5) The apparent discrepancy between the chemical and electrochemical action of nitric acid on copper is due entirely to a difference in the conditions under which the two sets of reactions have been performed. F. J. B.

**359. Electrolysis of Dilute Solutions of Acids and Alkalies at Low Potentials; Solution of Platinum at the Anode by a Direct Current.** G. Senter. (Faraday Soc., Trans. 2. pp. 142-149; Discussion, p. 149, Dec., 1906. Electrician, 57. pp. 538-540, July 20, 1906.)—Electrolysis of dilute solutions of sulphuric acid and of sodium hydroxide, using platinum electrodes, the cathode platinised, the anode unplatinised, and a current density of  $1.2 \times 10^{-2}$  amp. per sq. cm. at a potential of 1.4-1.55 volts, produces a very small amount of an oxidising substance at the anode, which is not hydrogen peroxide, is very stable, especially in alkaline solution, and is not destroyed by boiling. With the dilute acid small amounts of platinum are dissolved from the anode, the solvent action depending upon the length of time the electrode has been in use. W. H. S.

# REFERENCES.

**360. Presence of Neon in Radio-active Minerals.** R. J. Strutt. (Nature, 75. p. 102, Nov. 29, 1906.)—A note recording the finding of a trace of neon in the two minerals zircon and cyrtolite, the quantity present being probably less than 1/300th part of the helium. The method of separation used was that of Dewar's charcoal. J. J. S.

**361. Differences in Chemical Phenomena produced by Electric Heating and by other means of Heating.** Berthelot. (Comptes Rendus, 144. pp. 53-55, Jan. 14, 1907.)—The author points out the inaccuracy of regarding as identical the mechanism and theory of reactions produced by electrical agency and by purely calorific means. W. H. S.

**362. Use of Calcium in Refining Metals.** Brandenburg and Weins. (Engin. and Mining Journ. 82. p. 484, 1906. Metallurgie, 4. p. 26, Jan. 8, 1907. Abstract.)—The authors recommend the use of briquettes made by compression of chips of calcium (e.g., turnings) with chips of copper, bronze, or steel in the refinement of each of these metals or alloys. Calcium-aluminium briquettes may be used for cast iron. F. R.

**363. New Colorimeter for Determination of Carbon in Steel.** C. H. White. (Iron and Steel Inst. Journ. 72. pp. 622-625, 1906. Amer. Inst. Mining Engineers, Bull. 11. pp. 748-748, Sept., 1906.)—A double-wedge apparatus.

**364. Segregation in Steel Ingots.** J. E. Stead. (Engineering, 82. p. 405, Sept. 21, 1906. Abstract of paper read before the British Assoc. at York. Eng. Mag. 82. pp. 427-429, Dec., 1906. Metallurgie, 4. pp. 65-69, Feb. 8, 1907.)—The author's conclusions, though summarised, are too lengthy for reproduction. [See also Abstracts Nos. 1480 (1906) and 821 (1906).]

**365. Solvent Properties of Solutions.** R. Riedel. (Zeitschr. Phys. Chem. 56. pp. 242-253, July 17, 1906. Abstract of Dissertation, Breslau.)—The ratio of distribution of aniline between water and toluene is examined. T. M. L.

**366. Structure of Electro-deposits.** C. F. Burgess and O. P. Watts. (Amer. Electrochem. Soc., Trans. 9. pp. 229-237; Discussion, pp. 237-238, 1906.)